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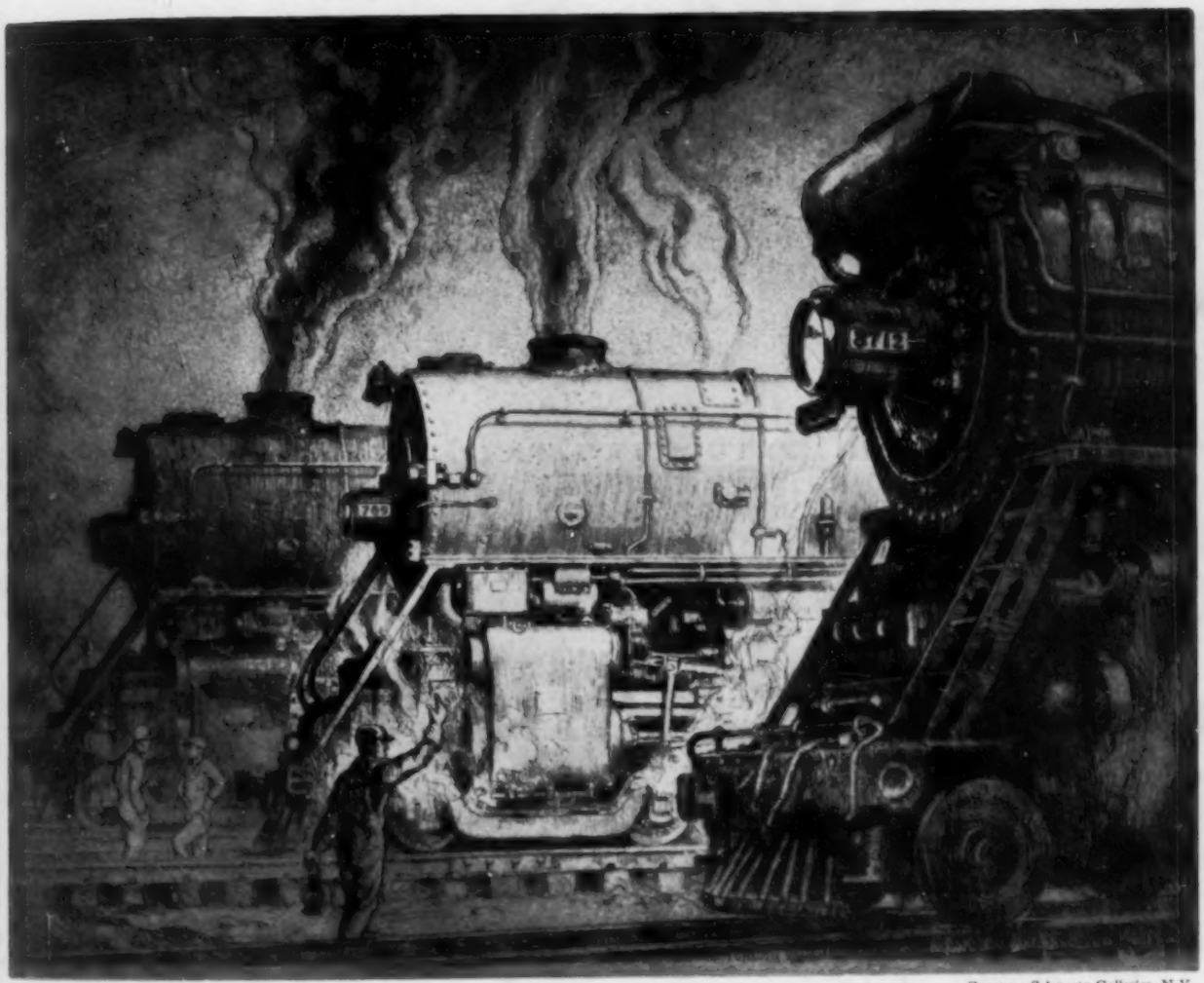

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GIANTS ON CALL

An Interpretation of Transportation

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Volume 1 — Number 9

JUNE 1931

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LOAD TEST ON ONE PILE
WENDELL PHILLIPS Sr. HIGH SCHOOL
CHICAGO
Pile 28' Long Load 60 Tons Settlement ⅛

Paul Gerhardt, Architect *Lieberman & Hein, Consulting Engineers* *Chris. Paschen, City Bldg. Commissioner* *Harvey A. Hanson Constr. Co., Genl. Bldg. Con.*

These tests proved the superiority of Straight-shaft Piles over Tapered Piles—the contract was awarded to MacArthur

LOAD tests on Tapered Piles and on MacArthur Straight-shaft Piles were made in the presence of Paul Gerhardt, Architect, Lieberman & Hein, Consulting Engineers, Julius Floto, Structural Engineer, E. H. Ward & Co., Inspecting Engineers, Chris. Paschen, City Building Commissioner, and Harvey A. Hanson Construction Co., General Building Contractor.

The tests proved again that MacArthur Straight-shaft Piles, because of greater end-bearing and greater skin friction, had greater load-bearing value, and that a tapered pile may be "hung up" by a dense strata near the surface while its point rests in soft soil which has no supporting value.

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Overshadowed by Perpetual Snow

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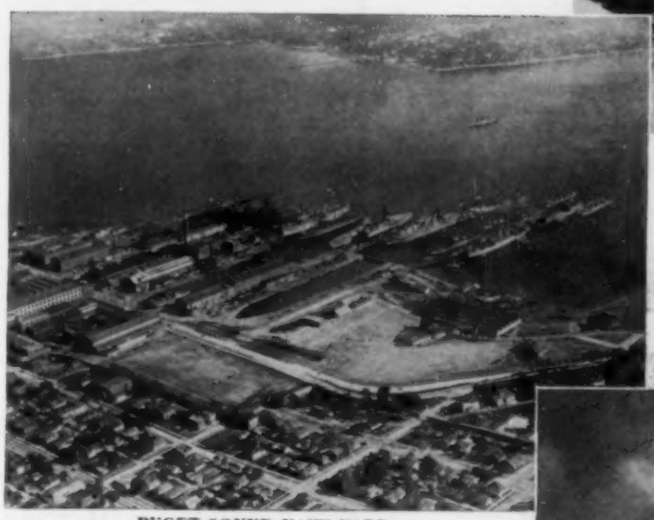
Ten and Twelve Feet in Diameter



PUGET SOUND NAVY YARD
Entertaining the Pacific Fleet

STACK OF TACOMA'S COPPER SMELTER
600 Feet High

MT. RAINIER (TACOMA) FROM PARADISE VALLEY
Elevation, 14,408 Feet

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July 8th to 10th, 1931

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Among Our Writers

ELISHA LEE ably fills a high executive position with the Pennsylvania Railroad, in the employ of which he has been since his graduation from the Massachusetts Institute of Technology in 1892.

G. R. YOUNG, by order of the Department of War, is now making an extensive study of the Oder, Elbe, Weser, Rhine, and other European river systems, with special reference to regulatory works and their effect.

J. D. ARTHUR, JR., a graduate of both West Point and Massachusetts Institute of Technology, has had an active career in the Corps of Engineers.

WARREN T. HANNUM, also a Military Academy graduate, through successive promotions became Lieutenant-Colonel, Corps of Engineers, in 1924.

J. GORDON BOHANNAN, a prominent member of the Virginia Bar, has been identified with the American Association of Port Authorities.

HENRY G. SHIRLEY, as Road Engineer for Baltimore County, Md., designed and erected over 400 concrete highway bridges.

LYTLE BROWN taught military and civil engineering at West Point for four years, was City Engineer of Manila, and built the Wilson Dam.

E. J. DENT, as Army Engineer, supervised the building of the Washington Aqueduct and Filtration Plant, and has been active in bridge, tidal gate, and dike construction along the Potomac River.

V. P. CONROY, a 1923 graduate of Annapolis, has served for two years as gunnery officer aboard the U.S.S. *Colorado*.

GEORGE C. KENNEY entered the Aviation Section of the Engineers' Reserve Corps as a private in 1917. While in active war duty, he received two decorations.

KENNETH WHITING, a graduate of the U.S. Naval Academy and a pupil of Orville Wright, became a Naval Aviator in 1915. He was the first Executive Officer of the U.S.S. *Langley*, the Navy's first airplane carrier, and also of the U.S.S. *Saratoga*.

RAYMOND S. PATTON, since his graduation from Western Reserve University in 1904, has been continuously with the U.S. Coast and Geodetic Survey and is now its Director.

GERARD H. MATTHES, a specialist in irrigation, flood control, power development, and navigation projects, is in charge of studies and surveys of Virginia and North Carolina streams.

MILLARD A. BUTLER was for 17 years an engineer with the Great Northern Railway. Since 1928 he has been identified with Ulen and Company, having directed their port, harbor, and railroad work in Persia.

CHARLES H. STEVENS has for a number of years been prominently identified with the development of transportation facilities in the City of Philadelphia. He is a Director of the Society and Chairman of its Committee on Publications.

P. A. BEATTY has had over 30 years experience on dam, reservoir, sewerage, and water works projects. He was in charge of construction of the Gun Powder Dam and Reservoir of the Baltimore Water Supply.

WALTER H. TAYLOR, 3d, became Assistant City Engineer of Norfolk in 1895 and has served that city continuously since.

J. N. CHESTER specializes in water works, sewerage, and sewage disposal. He is an expert on pumping machinery and on public utility rate making.

VOLUME 1 NUMBER 9

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VOLUME 1 JUNE 1931 NUMBER 9

Transportation Facilities of a Modern Railroad

Pennsylvania Railroad Expands Its Public Services

By ELISHA LEE
VICE-PRESIDENT, PENNSYLVANIA RAILROAD, PHILADELPHIA, PA.

OF a total of 26 billion dollars invested by the railroads of the United States during the one hundred years of their existence, an astounding proportion has been spent for betterments in the past eight years. Competition by highway, waterway, and air traffic has not only necessitated improvements in track equipment and motive power but has also demanded that the railroads themselves enter these fields. At the Norfolk Meeting of the Society in April, Mr. Lee took advantage of the occasion to make several announcements concerning the plans of the Pennsylvania Railroad for giving more service to the public. Of especial interest are the development of a 152-lb. rail section, replacement of local freight trains by motor trucks, the use of portable sealed containers for freight in less than carload lots, the transportation of detachable truck bodies by rail, the development of passenger bus enterprises, the expansion of transatlantic passenger service, and a 24-hour coast-to-coast air service.

THROUGHOUT their century of existence, American railroads have presented an outstanding illustration of a progressive and constantly advancing industry. In the last eight years they have expended on the improvement of their properties about six and three-quarter billion dollars, which is roughly equivalent to two-fifths of the entire net investment in their plants at the opening of the World War.

This great sum has been expended virtually without any territorial expansion of the systems. It has been devoted to such items as the improvement of existing tracks and roadbeds, additional double and multiple tracking, the enlargement of yards, the rebuilding or strengthening of bridges, the elimination of grade crossings, electrification, vastly improved signals, locomotives of greatly increased tractive power, freight cars of larger capacity, and passenger cars built for a maximum of safety, luxury, and convenience.

In other words, during the eight-year period of this expenditure, the railroads were to a large extent being rebuilt and renewed internally, and their service, both passenger and freight, improved to an almost revolutionary degree in speed, dependability, regularity, and convenience. The railroads may safely challenge any other branch of industry, or of commercial or public service enterprise in this country or abroad, to produce a similar record of achievement in an equal length of time.

FIRST HEATS ROLLED OF NEW 152-LB. RAIL SECTION

It so happens that within the past few weeks the first actual work has been undertaken for the Pennsylvania Railroad in connection with a further forward step in railroad progress. This is believed to be of great importance and likely to exert an extensive influence on the future of railroad operation and construction. As it involves information of unusual interest to the engineering profession, it seems appropriate to call the attention of the Society to it. Yet the general public should be equally interested in this work because of its bearing on the progress of transportation by rail.

The Pennsylvania Railroad has been a pioneer in the adoption of many of the outstanding improvements in rail transportation, both as to road and equipment, having been one of the first lines in the United States to replace the old strap rail with the T-rail design. The fundamental features of this design have been followed for more than 75 years and are still in use by every railroad in the world.

Early in May, two of the country's largest steel manufacturers, the United States Steel and the Bethlehem Steel corporations, began rolling the first heats of a new section of rail, designed as the result of investigation and research carried on over a period of two years by committees of the Pennsylvania Railroad's own engineering department and of engineers and metallurgists of the two steel companies.

This new rail section, which weighs 152 lb. per yd., will be the heaviest and strongest ever built for regular service, and presents certain other important features of design. The committees perfecting it were formed at the instance of the Pennsylvania Railroad, which invited the cooperation of the steel companies in a joint analysis and study of the problem confronting the management. This problem was to find a rail that would carry increased traffic, with increased loads, at greater speed and with greater safety than had ever before been possible.

The Pennsylvania Railroad's present main-line standard-section rail weighs 130 lb. per yd., and is rolled in accordance with a design adopted in 1916. Since the war, however, increased traffic and changes in operating practices have resulted in much heavier train loads and greatly increased axle loads, accompanied by

growing costs of track maintenance. Therefore, the company's track maintenance engineers reached the conclusion several years ago that a rail stronger and heavier than the 130-lb. standard section would be required to stand up satisfactorily under the demands of modern operation, to reduce excessive track maintenance expenses, and to provide for future increase in service demands. In making this decision, full weight was accorded the fact that it is the company's policy to concentrate its traffic, particularly freight, in the heaviest train units possible, and that this process will without doubt be carried much further.

Loading Containers at the Warehouse Platform

Trucking Containers to the Railroad Yard

Transferring Containers to Flat Cars by Crane

DEVELOPING A COORDINATED TRUCK AND RAIL SERVICE

THE PROBLEM BEFORE THE COMMITTEES

When the two committees convened, the presentation of the problem included an analysis of the experience with the present 130-lb. standard section; the growth in size of locomotives, and of axle and wheel loads since its adoption in 1916; the life of the rail in the heaviest traffic territory; and other factors relating to its performance, together with a statement of expectations as to future requirements.

Taking advantage of the researches which the Pennsylvania Railroad is continually carrying on, the committee conducted investigations and adopted for its aim the determination of a rail section that would be sufficient in strength to carry 100,000-lb. axle loads at 100 miles an hour, as compared with a maximum of 80,000-lb. axle loads at 80 miles an hour under present-day operation.

As a result of these researches, the joint committees worked out a new rail section weighing 152 lb. per yd. It is $1^{3}/_{8}$ in. higher than the present standard 130-lb. section, and possesses approximately 75 per cent greater stiffness. So far as design is concerned, its weight and proportions have been most carefully worked out to meet the requirements of operation and maintenance, and to provide not only much greater strength, but also a track structure at once safer, smoother, and more durable. The new rail is intended for use in those portions of the railroad where the heaviest traffic conditions are encountered.

PRESENT RAIL SECTION RE-DESIGNED

The design studies made jointly by the railroad and the steel companies have had another interesting result, in that they have led to a re-design of the present standard 130-lb. section in order to incorporate in it the new features of shape and proportion which were worked out for the 152-lb. rail. Thus the steel companies are enabled to provide a much stronger rail at practically no increased cost over the present 130-lb. section. This re-design has resulted in a section weighing approximately 131 lb. per yd., but possessing about 22 per cent greater stiffness—a very material gain in strength with the use of substantially the same amount of steel. The 131-lb. section will be the standard for main-line track, except where dense traffic requires the use of the heavier rail.

With the cooperation of the steel companies, the railroad has thus produced two new types of rail—one 22 lb. heavier to the yard and 75 per cent stronger than the present standard, and the other only 1 lb. heavier to the yard but 22 per cent stronger.

It is unnecessary to state that the capacity of the track to sustain heavy axle loads and high speed is a most important factor in railroad operation. Hence, the notable gains in rail strength given by these two new designs pave the way for a further important development in high-speed mass transportation by railroad.

NEED FOR NEW SPLICE BARS

Simultaneously with the designing of the two new rail sections, the railroad conducted with the steel companies an investigation and study of the splice bars which fasten the rails together at the ends.

As a result of these researches, new splice bars have

been designed, particularly for use in connection with the new rail sections. They incorporate features not extensively used before which, the committees believe, will produce improved conditions at the rail joints, lengthen the life of the rail, reduce its maintenance, improve its riding qualities, and give at the same time a larger factor of safety.

RAIL AND HIGHWAY TRANSPORTATION COORDINATED

Transportation progress is by no means confined to internal railroad affairs. Some of the most important and far-reaching developments now under way require the harmonizing of relations between railroads and highway, water, and air transportation facilities, and the extension of the scope of direct participation by the railroads in these forms of transport service.

The rapid growth of highway transportation, especially in this country, has been one of the most remarkable phenomenon of present-day life, and the problems arising out of its effect on the railroads are among the most important in the economic life of the country. There are two possible ways for railroad management to view highway transportation—as a menace or as an opportunity. The Pennsylvania Railroad believes that the second is unquestionably the sound view and bases its policies entirely on it. Since 1923, in fact, it has been actively engaged in the coordination of rail and highway service in the territory traversed by its lines. However, only a brief summary of what is being accomplished can be given.

In the field of freight service, peddler or local freight trains are being replaced by trucks, operated under contract to perform station-to-station service on lines of light traffic. At present, 49 such routes, covering 1,770 route miles daily, are being operated with large resulting economies.

Between a number of important cities on the company's lines, portable containers are in use. These are capable of being carried either on motor trucks through city streets or on specially equipped flat cars between cities. The theory of this service is that trucks should be permitted to function where they are most efficient, which is in the terminal zone between store door and rail head; while the inter-city rail haul is performed by the railroad with much greater efficiency and economy than is possible in trucking.

USE OF DETACHABLE AUTO TRUCK BODIES

The Pennsylvania Railroad is about to take a further step, the transportation by rail of detachable automobile truck bodies, the possibilities of such a service between New York and Philadelphia having been studied with great care. Railroad terminal costs in both of these cities are very high, and a large volume of freight is trucked between them. A careful consideration of the situation has led to the belief that by cooperating with the truck owners, the railroad can carry portable truck bodies for them between these cities for approximately half the cost of making the whole run by truck. The truck will, of course, function ideally in the terminal district between store door and rail head.

Some of the larger truck operators have stated that, with the inclusion of a proper amount for depreciation, the average costs of trucking are at least 30 cents a mile for each vehicle. Basing its rates on a truck body 20 ft. long, the railroad proposes to charge $15 for the haul of 100 miles between New York and Philadelphia, which is just half the trucker's charge. The service will be extended if the experiment proves successful.

This form of service, for which the railroad will shortly ask authorization from the Interstate Commerce Commission, carries with it the important possibilities of reduced transportation costs to the public and, at the same time, increased net returns to both the railroad and the truck operators.

FEWER PASSENGERS CARRIED

In common with other railroads, the Pennsylvania has lost passenger business to the highways. Since 1923

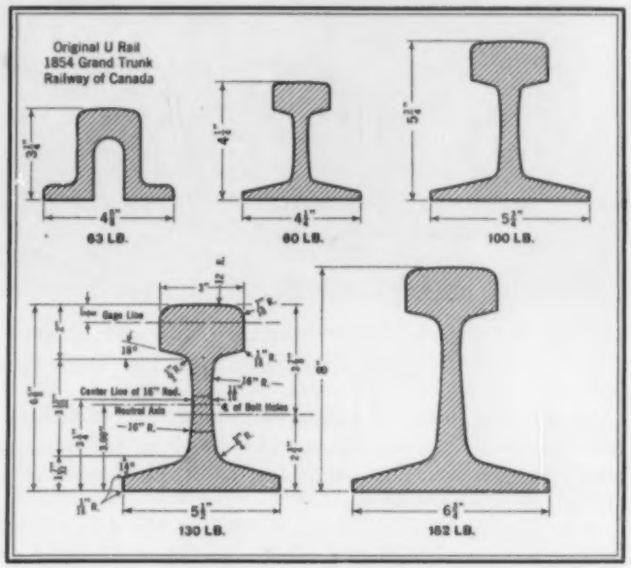


FIG. 1. PENNSYLVANIA RAILROAD'S NEW 152-LB. RAIL
Comparing 75 Years of Development in Rail Steel

the decrease in the number of passengers carried has been 34 per cent, and in passenger revenues 29 per cent. Our studies of this problem show, beyond question, that the major part of these losses is due to the operation of private automobiles. It seems evident that the buses have taken no more passengers than would have gone to the interurban electric railroads, had they survived and progressed.

Nevertheless, the railroad recognizes the bus as a real and growing factor in modern transportation, and accordingly it has engaged in extensive activities for the purpose of coordinating bus service with its rail lines. Included in these activities are the outright acquisition of a number of bus enterprises and the securing of a substantial interest in the Greyhound Corporation. In addition to paying good returns, these investments have resulted, indirectly, in eliminating a large volume of unprofitable train service.

It is our belief that common carrier service by bus, and probably by truck, should be brought under Federal regulation, but not for the purpose of restricting it, or of artificially diverting any of its traffic to the railroads. The only type of regulation advocated is that intended

to foster the healthy development of highway transport, with the single reservation that the railroads be allowed to engage in it on the same terms and under the same conditions as any other interests.

HANDICAP OF RESTRICTIVE LEGISLATION

The entire future of the railroads lies in their ability to supply any form of transportation service for which there is a public need or demand. Artificial restrictions barring them from any particular field of transportation should, therefore, be removed.

NEW ELECTRIC LOCOMOTIVE, CLASS 0-1
For Use on the New York-Washington Line of the Pennsylvania Railroad

For instance, they should be freed from the restrictions of the Panama Canal Act, which forbids their participation in shipping service on the Great Lakes and in the coastal and intercoastal trade, and from those of the Denison Act, which extends the restrictions of the Panama Canal Act to apply also to inland waterways. If it is the policy of the Government to build inland waterways, then the railroads should be free to operate lines upon them on the same terms as any other corporation or individual.

Also, the railroads should be freed from the handicap of competition with subsidized transportation, such as is now being rendered by the Government barge lines on the Mississippi and Warrior rivers, which charge rates representing, at a conservative estimate, less than half the actual cost of the service. Not only are these lines operated in direct competition with the railroads, but the railroads are forced to make through rates with them, thus short-hauling themselves and cutting their own revenues.

As a crowning piece of injustice, the Government barge lines, under the terms of the Denison Act, are for sale to anyone wishing to buy them, except a railroad company, although it would naturally seem that, if any interests are in a position to operate successful and economical barge service on the inland waterways, it would be the railroads, in coordination with their existing facilities.

As evidence of the sincerity of the desire of the Pennsylvania Railroad to participate in those forms of water transport from which it is now barred by uneconomic law, the fact should be noted that it once operated a splendid fleet of ships on the Great Lakes, before its flag was driven from those waters by the passage of the Panama Canal Act. At the present time, the Pennsylvania has substantial investments in two transatlantic shipping enterprises, against which, fortunately, the restrictions of the Panama Canal Act do not apply.

One of these lines, the Baltimore Mail Steamship Company, will start operations on July 2, with the sailing of the City of Baltimore from Baltimore to Hamburg, by way of Hampton Roads, Va., and Havre, France. The vessels to be used in this service have been completely rebuilt. They will carry only one class of passengers but every possible comfort will be provided, including private bath rooms, at rates ranging from $100 to $180 a passenger. The ships are 506 ft. long, with a displacement of 15,000 tons, and are equipped with refrigerator space for meats and other perishable freight. One of the five vessels to give weekly service from Baltimore and Hampton Roads to Germany and France will be named the City of Norfolk and one the City of Newport News.

COAST-TO-COAST AIR SERVICE

American railroads have given their loyal support to the encouragement of commercial flying and to its coordination with their own services. Naturally, the Pennsylvania Railroad is proud of the fact that it was a pioneer in this respect, having started the first 48-hour, coast-to-coast, rail-air service a little less than two years ago. To this has now been added a 36-hour all-air service, involving an overnight stop, which will be eliminated when the lighting of the airways is completed, with a reduction of the time to 24 hours.

The railroads of the country have passed through two distinct periods. The first was that of building and extending their lines; the second, that of developing these lines and bringing their service and equipment up to modern standards. We are now entering a third era, characterized by expansion into the new forms of transport which are the product of the present generation.

Granted a fair field and no favor, there is every reason to expect that the years to come will see all the important railroad systems actively using the highways, waterways, and airways to supplement the locomotive and the train in rendering a more comprehensive and useful service to the public than has ever before been possible. Moreover, under just and constructive regulation, the earnings and credit of these systems should be assured beyond the possibility of question.

The Atlantic Intracoastal Waterway

A Protected Inland Route from Boston to Miami

By G. R. YOUNG
MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
MAJOR, CORPS OF ENGINEERS, U.S.A., DISTRICT ENGINEER, NORFOLK, VA.

THE Atlantic Intracoastal Waterway is the name given to a sheltered water route that extends, or is planned to extend, from Boston to Miami, Fla., a total distance of nearly 1,800 miles. It is probable that one section or another of it is known to all engineers interested in waterways, either directly or through the medium of technical discussions. The route as a whole, however, is not so well known. In this paper, abstracted from that presented at the Norfolk Meeting of the Society before the Waterways Division, April 16, 1931, Major Young describes the waterway in its present condition and as projected, and discusses its utility and commercial possibilities.

NOTHING comparable to the Atlantic Intracoastal Waterway exists or can exist anywhere else. This fact is due to two peculiarities in the formation of the eastern coast of the United States, of which one is unusual and the other unique.

From Chesapeake Bay almost to the tip of Florida, the formation of the coast line is such as is found nowhere else in the world or anything like so large a scale. I refer to the so-called sea-islands or barrier beaches, consisting of a chain of islands, usually long and narrow, separated by occasional inlets and composed almost entirely of sand, that lie between the Atlantic Ocean and the mainland. While these islands are in general irregular in form, they have the common characteristic of presenting a fairly continuous front to the ocean, and of sheltering behind them bodies of water which are, or can easily be made, navigable.

There are only a few sections of the southeastern coast where barrier islands do not exist and the mainland faces the ocean. The longest is the stretch from Beaufort, N.C., to Winyah Bay, S.C., of which considerably over half has no barrier. Another is the gap just south of Norfolk. A third is south from the mouth of the St. John's River. Elsewhere, the discontinuities in the natural barrier are fairly short.

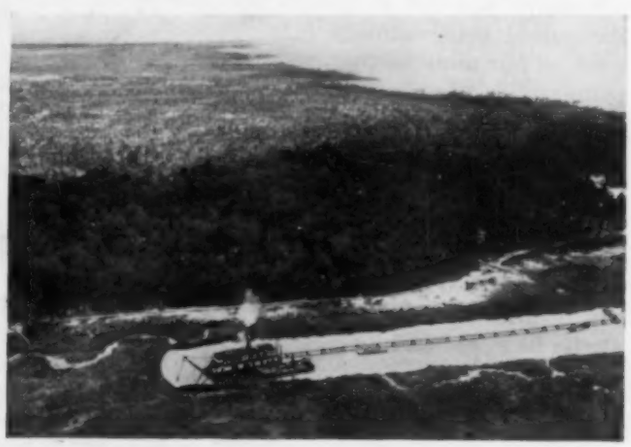
The middle Atlantic coast presents a second geographical phenomenon, its indentation by three great bays or estuaries: Chesapeake Bay; Delaware River and Bay; and the Hudson River, with New York Harbor and Bay at its mouth. By a curious coincidence, each of these waterways approaches closely to its neighbor at some one point. At the head of the Delmarvia Peninsula, the airline distance from Chesapeake Bay to the Delaware River is only 22 miles; and from the Delaware River at Trenton to lower New York Bay is only 30 miles.

Around these bays clustered many of the original European settlements, and the area adjacent to them has ever since been a center of population and industry. Artificial canals across these two narrow necks would provide a sheltered route from Norfolk to New York and up the Hudson. This was of particular importance in the early days, when the Hudson and Mohawk rivers, later extended by the Erie Canal, formed the most practicable freight route into the new Northwest.

A third geographical phenomenon is found on the coast between New York and Boston. Hell Gate and Long Island Sound provide a more or less sheltered route to the head of Buzzard's Bay. The short cut across the neck of Cape Cod, long discussed but not accomplished until the twentieth century, enters Massachusetts Bay at a point about 60 miles from Boston.

There was then, first a potentially sheltered coastwise route from Boston to New York, which required a canal across Cape Cod; second, a potential inland route from New York to Norfolk, which required two canals to connect the three great bays of the middle Atlantic coast; and third, a potential inland route from Norfolk to Miami behind the sea-islands or barriers, which re-

THE WATERFRONT AT SAVANNAH, GA.



DREDGING FROM THE CAPE FEAR RIVER TO MYRTLE SOUND

quired that the different sections be linked together where the natural channels were shallow, crooked, or missing. The entire system, conceived as an integrated whole, is the Atlantic Intracoastal Waterway.

THE WATERWAY IN THE PAST

The geological cause of the barrier is a matter of dispute, but however the formation may have arisen, its existence has profoundly affected the economics of our southeastern coast. Over most of their commercial history, the different sections of the waterway have been improved by private or state enterprise, with a view to local needs. The cut across the Delmarvia Peninsula, and the cut from Trenton to New York Bay, conceived in the eighteenth century, were made by private capital in the nineteenth. South of Norfolk, two cuts (alternate routes) were made to link Chesapeake Bay to the North Carolina Sounds: the Dismal Swamp Canal, surveyed by George Washington and built in the eighteenth century, and the Albemarle and Chesapeake Canal, started a little before the Civil War. The Florida East Coast Canal, a shallow improved waterway behind the barrier beaches of Florida, was also built by private capital. Many other short cuts or side routes have been made along the coast between Virginia and Florida.

The larger of these commercial enterprises were put through in the early days. In the later stages of their history they generally ceased to be successes. The reason is that they were built for shallow-draft navigation, which, except for local or special movements, was inherently less economical than railroads, even on fair terms of competition. In the late nineteenth century a considerable commerce still moved on various sections of the waterway, but it became characteristically low-grade and short-haul, serving localities and dealing with commodities not appropriate for or available to railroad service.

It was nevertheless believed by many—and experience has proved this to be the case—that even individual stretches of the waterway, if improved to handle modern navigation, would be commercial successes; and further, that the linking of the sections into a connected system would greatly increase such success.

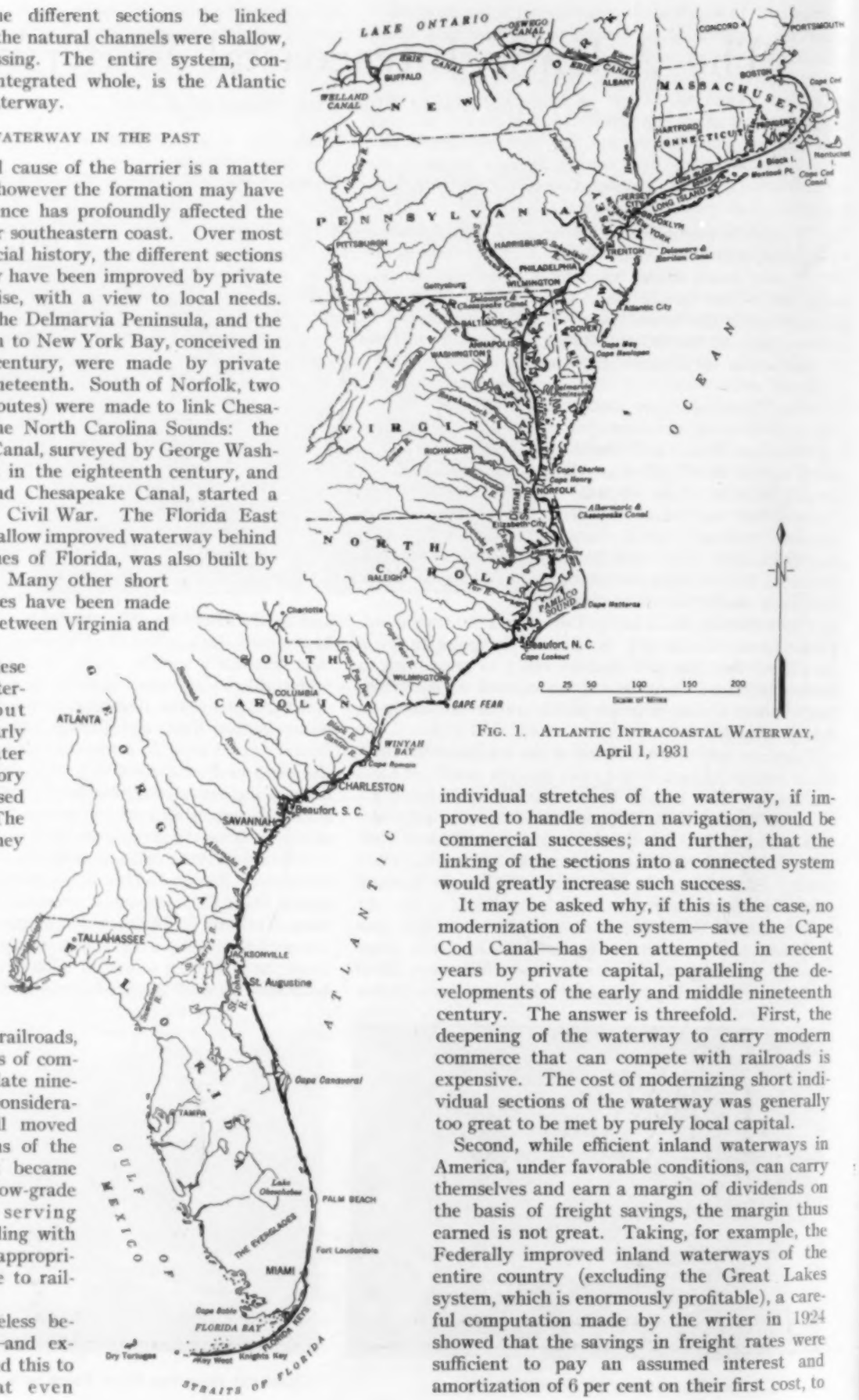


FIG. 1. ATLANTIC INTRACOASTAL WATERWAY, April 1, 1931

It may be asked why, if this is the case, no modernization of the system—save the Cape Cod Canal—has been attempted in recent years by private capital, paralleling the developments of the early and middle nineteenth century. The answer is threefold. First, the deepening of the waterway to carry modern commerce that can compete with railroads is expensive. The cost of modernizing short individual sections of the waterway was generally too great to be met by purely local capital.

Second, while efficient inland waterways in America, under favorable conditions, can carry themselves and earn a margin of dividends on the basis of freight savings, the margin thus earned is not great. Taking, for example, the Federally improved inland waterways of the entire country (excluding the Great Lakes system, which is enormously profitable), a careful computation made by the writer in 1924 showed that the savings in freight rates were sufficient to pay an assumed interest and amortization of 6 per cent on their first cost, to

meet their operating and maintenance charges, and to show a margin of "dividends" of around 4 per cent. Such a margin has been too narrow, in the past generation or two, to attract large amounts of private capital on a more or less speculative venture.

Third, there was a well founded fear that any extensive waterway development would provoke discriminatory action by the railroads, through manipulation of freight rates. It was felt that only the Government was strong enough to meet this competition, and if necessary to carry a waterway through a lean period until the readjustment of rates, and the development of an effective navigation technic, would make it a success.

Principally for these three reasons, the development of the Atlantic Intracoastal Waterway by private enterprise came to a standstill, and during the past 30 years the Government has progressively stepped into the field. Each section was taken over for improvement only when it was felt, after a dispassionate economic study, that it could carry itself on its own merits. Neverthless, from the beginning of the twentieth century at least, the Government has thought of the waterway as a potentially single and integrated whole, and the developments that it has made have been progressive steps toward that end. At the present time, the projects completed or under way provide for a continuous improved waterway from Philadelphia to Miami, Fla.

The following brief description of the waterway as it stands today will begin with New York, for the reason that the section extending to Boston is in a somewhat different class from the rest of the route. It is in several places exposed to a considerable part of the force of the ocean, and while it is extensively used by barges and pleasure craft, it is nevertheless rather a sheltered route for coastwise vessels than a true "inland waterway."

THE WATERWAY OF THE PRESENT

As seen by the map, Fig. 1, the waterway from New York to Philadelphia is via New York Bay, up the Raritan River to New Brunswick, across New Jersey by the Delaware and Raritan Canal to Trenton, and down the Delaware River. There is ample water at the two ends. The controlling element is the canal. This was built in the nineteenth century by private capital, and is known as the Delaware and Raritan Canal. It is now held by the Pennsylvania Railroad, which parallels it, on a 999-year lease. The canal is in fair physical condition, and has a controlling depth of about 7 ft. It has, however, the extremely serious drawbacks of passing through the heart of a manufacturing center, and of being very badly obstructed by bridges over which moves a dense traffic.

The Delaware River from Trenton to Philadelphia has a 12-ft. channel, to be increased in depth to 20 ft., and below Philadelphia it has a 35-ft. channel. About 40 miles below Philadelphia is the entrance to the next link of the waterway, the Delaware and Chesapeake Canal. This was originally completed by private capital in 1829 as a lock canal. It was taken over in 1919 by the United States, and has been converted to a sea-level canal with a project depth of 12 ft. The work of modernization extended from 1922 to 1927, and consisted in dredging 16,000,000 cu. yd. of material and lowering the canal to sea level by removal of the locks. The cost, considering the magnitude of the work, was not great—a total of about $10,000,000 for new work, of which about $2,500,000 was for the purchase of the canal.

The hydraulic aspects and the construction problems of this work have been discussed more generally in engineering literature than have those of any other section of the waterway. They were ably summarized by Earl I. Brown, M. Am. Soc. C.E., Colonel, Corps of Engineers, in PROCEEDINGS for February 1930.

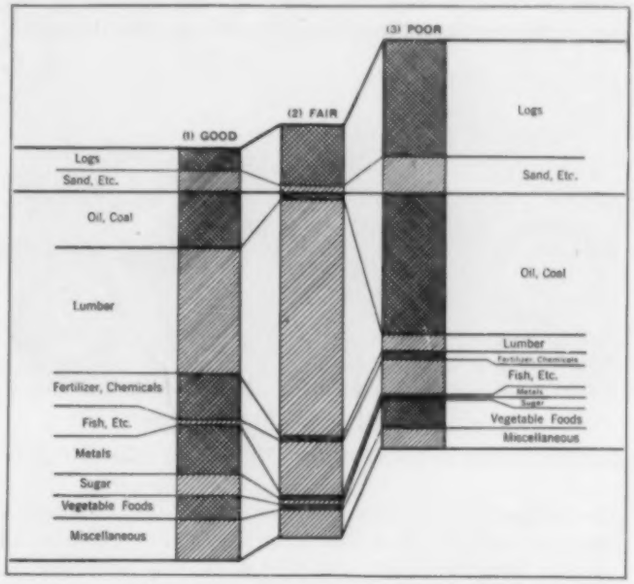


FIG. 2. SECTIONAL DISTRIBUTION OF COMMERCE, 1929

The canal opens into Elk River, an arm of Chesapeake Bay. Thence the inland route follows the bay to Hampton Roads and Norfolk Harbor. Chesapeake Bay is the least sheltered section of the waterway south of New York. Large-scale freight traffic has evolved a type of boat and heavy barge satisfactory for bay use, and at the same time of suitable draft for the waterway proper. For smaller vessels, the bay has the advantage of a great number of sheltered harbors, affording prompt refuge in storms.

Norfolk Harbor, which opens on to Hampton Roads, is formed by the Elizabeth River and its three branches, the longest, or Southern Branch of which is the commencement of the next section of the waterway—the stretch from Norfolk to Beaufort, N.C. The first part of this is the Virginia Cut, an $8\frac{1}{4}$-mile canal running east from the Elizabeth River, and opening on the sounds of North Carolina. It has been taken over by the Government and improved to a depth of 12 ft. and a bottom width of 90 ft.

From the eastern end of the Virginia Cut, it is physically possible to go by water to the lower end of Pamlico Sound, a distance of 150 miles, without passing through any land cuts, and navigation was formerly by this route. Pamlico Sound, however, can become very rough, and a more sheltered route has since been created. The entire stretch of 198 miles has been completed to a depth of 12 ft., and is maintained at that depth.

An interesting complication has arisen at the northern end of this section. The old Albemarle and Chesapeake Canal, started a little before the Civil War, had a lock

in it, which was removed by the Government. The canal was thereby converted into an open waterway, and for the first time there was a free flow of water between the North Carolina sounds and the salt water of Chesapeake Bay. After the opening of the Government cut, it was alleged that the entrance of salt water from Norfolk Harbor was increasing the salinity of the northern sounds and having a deleterious effect on game.

A TOW OF BARGES NEAR NORFOLK, VA.
Such Barges Operate Efficiently from Philadelphia to Beaufort, N.C.

The subject was studied with great care, and ultimately Congress ordered that a new lock be built. Contracts for this have been let, and the work will probably be completed within a year.

The new lock is of course much larger than the old one, which in any case would have had to be scrapped. Its dimensions are 600 ft. by 75 ft. in the clear, and it is provided with two sets of gates, as the direction of flow is in general reversed at each tide. Congress limited its cost to $500,000, so that it has been necessary to design and build a structure which would ordinarily cost upward of $1,000,000 for half that sum. Various unusual features have had to be incorporated in the design as a result.

The next two sections of the waterway are from Beaufort, N.C., to the Cape Fear River, and the Port of Wilmington; and from the Cape Fear to Winyah Bay, S.C. On this coast the barrier is not continuous, and much of the stretch requires a land cut. No through waterway has ever existed here, and through traffic must at present make a somewhat risky trip in the open Atlantic. In 1927 and 1930, on recommendation of the Corps of Engineers, Congress adopted projects for these two sections, with a depth of 12 ft. in the northern and 8 ft. in the southern. Work is now under way on both. On the northern section, more than half of the cut has been completed, and the work is being pushed rapidly. On the southern section, which was only authorized by the last Congress, work has been started. The cost of these two stretches will total about $9,000,000.

At Winyah Bay the sea-island formation is again met with. The next stretch of the waterway extends to Charleston. This is the one really poor stretch south of Philadelphia for which no modernization project has been adopted. The waterway follows the winding tidal creeks, with some short land cuts, and not over 4 ft. can usually be counted on at low tide, though the tidal range of 5 ft. or more enables larger boats to get through with care. The War Department, in recommending the adoption of the Cape Fear River–Winyah Bay section, recommended also that the Winyah Bay–Charleston section be deepened to 8 ft., with appropriate width. Congress, however, withheld its approval from this portion of the work—it is understood because there was some local dispute as to the route chosen—and the matter has been referred back to the Corps of Engineers for further study.

The next two sections are those from Charleston to Beaufort, S.C. (there are two "Beauforts" on the waterway) and from Beaufort, via Savannah, to the St. Johns River and the port of Jacksonville. They are generally similar. The project depth is 7 ft. The southern section has a better channel than the northern. On both sections there is a deep fringe of sea-islands, of considerable area and irregular shape, with an intricate system of waterways behind them. A limited amount of dredging has sufficed to convert the Beaufort–St. Johns stretch into quite a good waterway, not as efficient as the Chesapeake and Delaware Canal or the stretch south of Norfolk, but much superior to the unimproved or partially improved sections. As the natural waterways are fairly good, and as the larger tidal range tends to compensate for the lesser depth of 7 ft., no large-scale work has been done here to date.

The last and longest stretch is from the St. Johns River, or Jacksonville, to Miami. The ocean front here resumes the character of a barrier beach, and the route of the waterway is dictated by this formation. The old Florida East Coast Canal was never very good, and in recent years it has fallen into disrepair at critical

TABLE I. EXTENT AND CLASSIFICATION OF THE SECTIONS OF THE WATERWAY

SECTION	EXTENT	CLASSIFICATION
Boston to New York	300 miles	Good
New York to Delaware River	100 miles	Poor
Delaware River to Chesapeake Bay	20 miles	Good
Chesapeake Bay	200 miles	Good
Norfolk to Beaufort, N.C.	200 miles	Good
Beaufort, N.C., to Cape Fear River	95 miles	No route*
Cape Fear River to Winyah Bay	95 miles	No route*
Winyah Bay to Charleston	75 miles	Poor†
Charleston to Beaufort, S.C.	75 miles	Fair
Beaufort, S.C., to St. Johns River	225 miles	Fair
St. Johns River to Miami	385 miles	Poor*
	Total 1,770 miles	

* Work is under way to make these stretches "good."
† Work recommended by the department to make this stretch "good;" no Congressional action yet.

TABLE II. A SUMMARY OF THE 1929 COMMERCE ON THE WATERWAY

CLASSIFICATION	SECTION	TONS	TOTAL VALUE	UNIT VALUE	TON MILEAGE	AVERAGE HAUL IN MILES
Poor	New York Harbor to Delaware Bay (D. & R. Canal)	56,000	$ 781,000	$13.95	———	———
Good	Delaware Bay to Chesapeake Bay	709,000	$45,545,000	$64.25	65,950,000	93
Poor	Dismal Swamp (Branch Route)	154,000	$ 2,190,000	$14.20	5,950,000	39
Good	Norfolk to Beaufort, N.C.	664,000	$28,207,000	$42.50	181,150,000	272
Poor	Winyah Bay to Charleston	46,000	$ 1,110,000	$24.10	1,080,000	23
Poor	Charleston to Beaufort, S.C.	140,000	$ 2,032,000	$50.75	1,210,000	28
Fair	Beaufort, S.C. to St. Johns River	600,000	$20,990,000	$35.00	19,960,000	33
Poor	St. Johns River to Miami, Florida	108,000	$ 3,307,000	$30.60	2,107,000	20

stretches, although much of the route has always had good depths. Congress adopted the project for modernization in 1927–1930, but the work was delayed by requirements for local cooperation in obtaining rights-of-way. Work has been started. Its estimated cost is $4,250,000.

The interest of the waterway to the Corps of Engineers, who are constructing and maintaining it, is twofold. It is an engineering problem, or rather a group of engineering problems, presenting widely varying features; and it is an economic problem. Congress looks to the War Department, not only to construct waterways, but also to recommend whether they will pay their way and carry an effective commerce. Our forecasts along these lines are usually the basis for the adoption of a project. Accordingly, we must study such on undertaking after completion, with great care, to see whether we have been right in this respect. The collection and analysis of commercial statistics thus form a vital element of the department's work. Such statistics must now be reviewed in order to ascertain whether the Nation is justified in undertaking this project.

Table I summarizes the different sections of the waterway, and designates each section as "good," "fair," or "poor" in its physical efficiency as a commerce carrier. These classifications are primarily a question of depth, but there has also been taken into consideration the existence of obstructions such as bridges and, in the case of the Delaware and Raritan Canal, the fact that the waterway is controlled by a railroad that parallels it.

A summary of 1929 commerce, in tons of freight, total and unit value of freight, ton-miles hauled, and average length of haul, is given in Table II. The Dismal Swamp Canal, a branch route, has been included for purposes

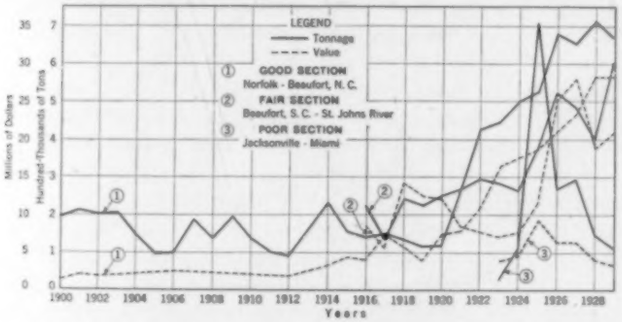


FIG. 3. GROWTH OF TONNAGE AND VALUE OF COMMERCE
On Three Typical Sections of the Waterway

of study and comparison. A great variation in all these figures will at once be noted, and particularly in the most important figure, which is ton-miles. Waterway advocates are too prone to speak of commerce in terms of weight or value, without considering the distance it moves; but rail and water rates, and the savings of water transportation, can only be computed after considering this distance.

TABLE III. DENSITY OF TRAFFIC IN 1929 ON CERTAIN SECTIONS

CLASSIFICATION	SECTION	TONS PER MILE
Good	Delaware Bay to Chesapeake Bay	33,800
Good	Norfolk to Beaufort, N.C.	3,350
Fair	Beaufort, S.C., to St. Johns River	2,660
Poor	Winyah Bay to Charleston	710
	All Railroads	10,350

It will be seen, for example, that while the tonnage of the Norfolk–Beaufort section is only about 6 times that of the longer St. Johns River–Miami section, the ton-mileage of the former is about 85 times as large. Similarly, the two first-class or highly improved sections of the waterway carry less than 60 per cent of the tonnage, but have nearly 90 per cent of the ton-mileage.

DREDGING THE INTRACOASTAL WATERWAY
South of Norfolk, Va.

It is next necessary to analyze the commerce of the different sections of the waterway, or rather the sections grouped according to their efficiency and modernization as good, fair, or poor. This is done in Fig. 2. Particular attention should be given to the first two classes: "logs," either floated or barged; and "sand, etc." Floated or barged logs require very little depth of water to move them; and while they may move on a large scale, and be in fact an important item of national commerce, it is seldom that a waterway needs to be extensively improved to permit their movement. In the case of sand and gravel, a large part of this movement everywhere consists of such materials dredged from the stream itself, and moved only a few miles, or sometimes only a fraction of a mile, to a screening plant. These materials must therefore be largely discounted by the analyst, as compared to other materials, in considering the merits of a waterway.

The sections in poor condition, then, are short-haul carriers of floated logs, low-grade building materials and fuel, and routes for the fish trade; the intermediate channels are primarily lumber carriers; and the thoroughly modernized sections carry a true general commerce, with a length of haul and a value comparable to that of an average railroad.

One other study is of interest in this analysis, the density of traffic, shown in Table III. A characteristic modernized section of the waterway has an average traffic density about five times that of a characteristic poor section, but only about one-third that of an average railroad.

Turning to a consideration of the trend of commerce on the waterway in the past, in Fig. 3 are plotted the tonnage and value of commerce on three characteristic sections. A "poor" section, the Jacksonville–Miami link, shows the value and tonnage of commerce for the past 7 years. The high 1925 peak is, of course, for the period of the Florida boom, and represents such products as sand and gravel used in road and building construction. Evidently there is little hope of development until modernization is completed.

Nothing could show more decisively the effect of modernization than the record of the "good" section, from Norfolk to Beaufort, N.C. For 20 years the old waterway showed the same lack of promise as the Jacksonville–Miami link. The channel was then modernized; and within 10 years the tonnage increased fivefold, and its value sevenfold.

Intermediate between these two is the section from Beaufort, S.C., to St. Johns River. It has a fair channel, systematically kept up and gradually improved, but with no sudden expansion of facilities. As a result, there has been a generally steady growth of commerce, with a tonnage and a value, at the end of the 14-year period, about $2^1/_2$ times those at the beginning.

THE WATERWAY'S BALANCE SHEET

There is, then, a striking increase in amount, value, and length of haul of commerce, as the waterway is improved. Is it sufficient, on a strict balance-sheet basis, to justify the Government's expenditures?

To answer such a question requires an elaborate study. The proper method is to ascertain the cost of movement of, say, one year's commerce, from origin to destination, and by reference to freight rates to see how much more it would have cost to move the same commerce by the most effective alternative means. The difference is the saving to the public, which goes on the credit side of the ledger. On the debit side we place a charge (fictitious, of course) of 4 per cent for interest on the Government's capital expenditure for new work. To this "paper" carrying charge we add the actual annual cost of maintenance and overhead.

A general analysis of the entire waterway is hardly practicable at this time, on account of the rapid changes in conditions as modernization proceeds.

An analysis was made of the Norfolk–Beaufort, N.C., section, four years ago. It showed that for 1925 there was a net balance of freight savings of $360,000 over the annual costs; and that the accummulated savings on this basis, since 1913, were over $2,600,000. Thus the section was paying its way, and yielding a "dividend" of nearly 9 per cent on the amount invested up to that time. Since then, there has been a considerable increase, nearly 30 per cent, in freight, and therefore presumably in savings; and a considerable increase in paper carrying charges, for the additional capital expenditure involved in finishing the project. As closely as can be estimated without elaborate computation, annual savings rose to about $430,000 (a "dividend" of about 7 per cent) in 1929, and fell to about $170,000 (a "dividend" of about $2^3/_4$ per cent) in 1930, due to large expenditures for deferred maintenance. The cumulative "dividends" or savings now amount to about $4,333,333.

THE FUTURE OF THE WATERWAY

What are the future possibilities of the waterway?

Referring to the general map, we see that from New York to Miami there is a series of navigable rivers, flowing generally southeast. A complete intracoastal waterway will tie them all together and the numerous ports at their mouths. It is thus a potential competitor of the land carriers and the coastwise steamers. Can it find enough commerce, in the face of this competition, to justify its existence?

In theory, it would seem that it could. As compared with the land carriers, it has the advantage of a cheaper cost of haul per mile. It has, however, three disadvantages: (1) a longer haul, from origin to destination, if the origin or destination is so far back from the coast that the water route is an arc of which the land route is a chord; (2) sometimes, though not always, a lesser speed; and (3) less elasticity, that is, the land carrier can reach more points than the water carrier.

As compared with coastwise shipping, it has two advantages: more elasticity, that is, it can reach more points than the ocean ships; and no rehandling, in the case of commerce originating and terminating on tributary waterways—that is, such commerce can move, inland, from origin to destination in one barge, but if moved by steamer it must be rehandled at the port or ports of call of the steamers. It has the disadvantages of less speed and sometimes, though not always, of greater cost per mile. The distance is sometimes less and sometimes greater than the coastwise distance.

Waterway traffic will probably never approach the volume of coastwise movement, or certainly that of rail movement. Railroads are, and will continue to be, the backbone of inland transportation. But, in many cases it has developed, and will increasingly develop, advantages over its competitors that will divert to it a considerable commerce, measured in millions of tons and hundreds of millions of dollars, with average hauls of between one and two hundred miles—perhaps more. Its southern section in particular will serve a function in linking up the coastal rivers, comparable on a smaller scale to that served by the Mississippi.

Will the system be extended? Two extensions have been advocated. One is a modernization of the link across New Jersey. This would produce a large commerce, but would be very expensive. Whether the benefits would balance the cost has been argued pro and con for many years. The department's most recent report expressed the opinion that the improvement was not now justified, and there the matter rests for the present. The other proposed extension is a cut across northern Florida to the Gulf, to shorten the water route around Key West, and perhaps eventually to join up with the Gulf Intracoastal Waterway, which now exists or is under construction from Mobile, Ala., to Corpus Christi, Tex. This Florida canal is now under study by a board of engineer officers.

Finally, there is one aspect of the waterway remaining to be touched on, its use by pleasure boats. Several thousand of these—accurate figures cannot be given, as statistics do not clearly separate the pleasure boats proper from the motor-propelled boats engaged in commerce—now travel the route, especially in winter, when there is a great movement south to the coast of Virginia, the Carolinas, Georgia, and Florida.

The department has never considered the pleasure-boat traffic as in itself a justification for the improvement of the route but has properly held that the waterway must stand or fall on its performance as a freight carrier. But, in the last analysis, the sole purpose of our national economic and transportation structure is to enable our citizens to enjoy themselves; and the pleasure boat movement, to my mind, deserves the warmest encouragement.

Chesapeake Bay Port Developments

At Washington, D.C., Baltimore, and Hampton Roads

CHESAPEAKE BAY, the great estuary which penetrates the states of Virginia and Maryland, has along its shores numerous port developments. On the Potomac River is the city of Washington, D.C., with its beautifully improved waterways; on the Patapsco River, the Port of Baltimore; and at the mouths of the Elizabeth and James rivers, the cities which together form the Port of Hampton Roads. The three articles which follow—abstracts of papers presented at the Norfolk Meeting of the Society in April—deal with these three important waterway improvements. Major Arthur and Colonel Hannum, whose papers were presented before the Waterways Division, review, respectively, progress in a non-commercial development at Washington, D.C., and the successful improvement of commercial facilities at the Port of Baltimore. In his article, presented at the Technical Session, Mr. Bohannan describes the developments which have taken place at the Port of Hampton Roads, and stresses the importance of unification of port facilities.

The Waterways of the National Capital

By JOSEPH D. ARTHUR, JR.

MAJOR, CORPS OF ENGINEERS, U.S.A.,
DISTRICT ENGINEER, WASHINGTON, D.C.

TO the average citizen, the waterways of the national capital suggest only the Potomac River, and the use of the plural is probably questioned. Yet Washington possesses other waterways of importance, whose value, however, largely depends on the connection with Chesapeake Bay and the ocean which the Potomac affords.

Photo by U.S. Army Air Corps

RECLAMATION OF POTOMAC FLATS COMPLETED

Colonial history contains many references to the part played in the life and commerce of the period by the many streams of tidewater Virginia. So it was only natural that the Potomac was considered when the question of a suitable location for the seat of the Government was raised. President Washington's home was located on the river; he was familiar with its navigable channel, suitable for seagoing vessels of the period and extending 110 miles above Chesapeake Bay, and he had already envisaged the eventual improvement of its non-tidal reaches as a potential link in a water route to the Ohio Valley. Undoubtedly it was largely his influence, as well as the political factors involved, which resulted in the act of Congress of January 1790, establishing the new capitol on the northern shore of the Potomac above the mouth of the Eastern Branch, now known as the Anacostia River.

At that time, the main channel of the Potomac followed closely the Virginia or southern shore. Had the city been located as thus provided, vessels would have been unable to approach nearer than one-half mile to their wharves. The correspondence of General Washington indicates that he appreciated this difficulty and that it prompted him to request authority to include within the District of Columbia the Anacostia River, which had ample depths close enough to shore to permit dockage at city wharves. In March 1791, Congress removed the limitations of the original act, and the President fixed the boundaries of the District of Columbia so as to include both shores of the Potomac and Anacostia rivers. Sub-

PRESENT CONDITION OF THE WASHINGTON CHANNEL

sequently, the part of the District originally within Virginia was returned to that state. As a result, many difficulties and disagreements in regard to jurisdiction have arisen.

It is thus seen that the exact location of the capital was largely dictated by commercial considerations. The absence of suitable navigation facilities in the city of Washington as first delimited formed the basis for one of the earliest pieces of Federal legislation.

Shortly after the Revolution, General Washington conceived the plan of extending navigation to Cumberland, Md., by means of lateral lock canals around Great and Little Falls, and the use of the natural river channel elsewhere. In 1785, a charter was secured from the Virginia and Maryland assemblies, and the "Potowmack Company," with Washington as its president, was organized to put this plan into execution.

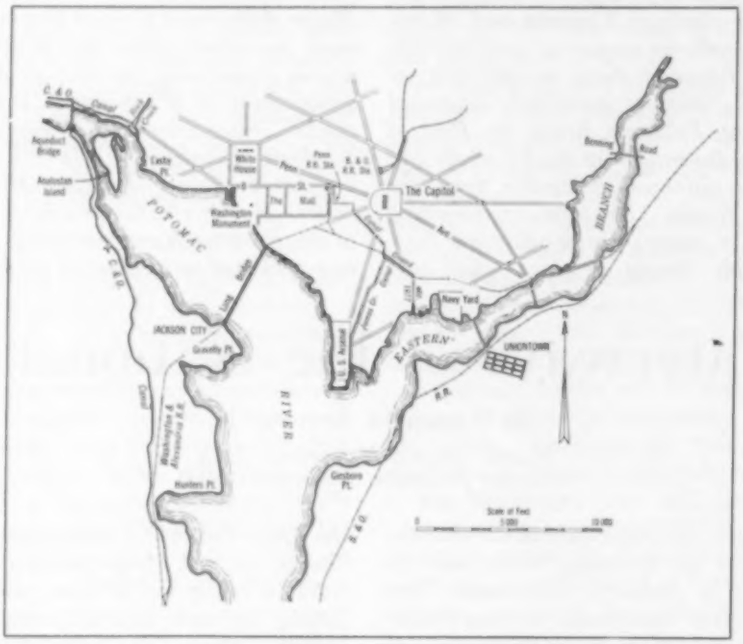


FIG. 1. THE WATERFRONT OF WASHINGTON, D.C., IN 1877

At Great Falls, on the Virginia shore, a canal 6,000 ft. long, equipped with five masonry locks 100 ft. long, 12 ft. wide, and 6 ft. deep over the sills, was constructed. At Little Falls, a canal 11,000 ft. long, with three similar locks, carried navigation around the obstructions existing there. The old lock walls are still in a fair condition, and the canal line is easily distinguishable on the ground. Because these structures represent the only remaining engineering work known to have been executed under the direct supervision of General Washington, as well as the first lock canal constructed in the United States, the American Engineering Council has proposed the preservation of these old ruins as a fitting memorial to Washington, the engineer.

The Potowmack Company was never a financial success; in 1828 it was declared bankrupt, and its assets taken over by the Chesapeake and Ohio Canal Company. This company eventually constructed and operated, as late as 1924, an artificial channel paralleling the river to Cumberland, using the waters of the river merely to feed its canal.

Although Washington's dream of a water route to the Ohio has never materialized, recent studies prove its practicability. Perhaps the day may come when transportation needs will make the scheme economically feasible, although the cost of providing the 81 necessary locks and a tunnel 16 miles long would be very high.

As early as 1805, records show that "mud machines" were engaged in removing the shoals which were beginning to appear in the Potomac opposite Washington. In 1806, a form of jetty was constructed to reduce the cross-sectional area and increase velocities in the main channel. Successive maps show a gradual shifting of the shoals, changes in channel location, and a continual increase in the marsh area along the city front.

Although the Potomac system above tidewater, four miles above Washington, drains some 11,500 sq. miles of territory, in its ordinary stages it is little more than a good-sized mountain stream. Until reaching the foot of 27th Street in Washington, it flows through a deep narrow channel with a rock or gravel bottom. At this point, the river in its original state suddenly widened to about 5,000 ft., or more than five times its width above. Quite naturally, the sediment carried by it during freshet stages, when it has at times discharged 400,000 sec-ft., was deposited in this wide area. As more and more of the watershed was cleared, the amount of deposit became greater and shoaling increased. The addition of sewage at Washington furnished all the essentials for the marsh formation which soon became a matter of concern. At the present time, this deposit in the existing channel averages about 175,000 cu. yd. per year, although in 1924 it amounted to 374,000 cu. yd.

In 1833, the Federal Government first undertook the improvement of the river. The suggestion was first made in 1857 that the improvement of navigation be combined with the reclamation of the marshes, but it was not until 1882 that the many investigations and studies resulted in a Federal appropriation, and construction was commenced on the present project of improvement. Records of the period suggest that it was perhaps the needs of sanitation rather than of navigation which finally forced action.

The work commenced at that time converted some 800 acres of marsh into what is now Potomac Park. A depth of 20 ft. was secured in the main Potomac channel, and an old meandering stream became the present Washington Channel, also 20 ft. deep. To flush this dead-end waterway, the so-called Tidal Basin, with its automatic gates, was included in the plan. These two waterways provide the city with about 9,440 ft. of water frontage available for terminal facilities, of which 7,500 ft. are now used for commerce.

In 1899, Congress provided for the removal of several obstructing shoals in the lower river, and a depth of 24 ft. is now maintained to the bay. It seems rather anomalous that a 24-ft. depth should be maintained up the Potomac to serve Washington, where a depth of only 20 ft. is available.

As early as 1743, seagoing vessels are reported to have docked on Bladensburg, on the Anacostia River, the other waterway of the capital. This is well above the present head of navigation. As in the case of the Potomac, and for the same reasons, extensive marsh areas soon developed along the shores of the Anacostia, and there was a gradual shoaling of its upper reaches. Agitation for the reclamation of these flats commenced in 1891, but an appropriation was not secured until 1911. Since that date work has been in progress, and it is expected that by 1938 the project will be completed and some 1,305 acres of marsh will have been converted into Anacostia Park lands. In addition, water areas of 468 acres, with depths sufficient to accommodate pleasure boating, will be provided.

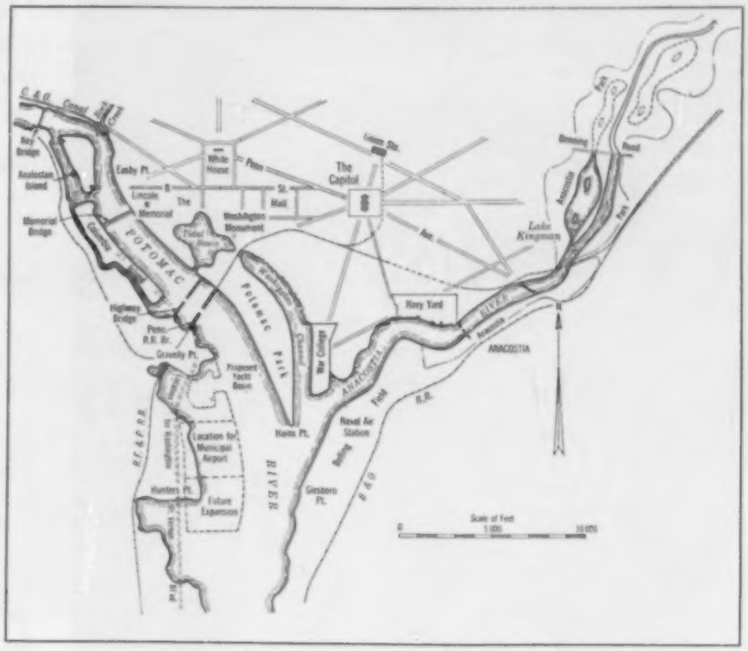


FIG. 2. WASHINGTON WATERFRONT AS IT IS TODAY

This project will represent the dredging of approximately 11,500,000 cu. yd. of material; the construction of about 80,000 lin. ft. of masonry sea walls; the erection of a bridge and a lock; and the purchase of the necessary riparian rights—all at a cost of approximately four million dollars.

In so far as commerce is concerned, the head of navigation is the Navy Yard, to which point a depth of 20 ft. is maintained. Of the 22,800 ft. of waterfront along this portion of the river, 14,800 ft. are occupied by parks and by Army and Navy airports; 2,500 ft. are used by the Navy Yard; 1,000 ft. are devoted to District of Columbia activities; and only 5,500 ft. are available for terminal facilities.

Although the selection of Washington as the site for the capital was greatly influenced by the needs of commerce, no effort was apparently made in its early history to develop it as an industrial center. Such development has not been encouraged by either Congress or the citizenry. As the seat of the Government, it is perhaps proper that its largely residential character be retained.

This characteristic has, of course, been reflected in the commercial statistics of its waterways, which show that inbound shipments constitute nine-tenths of the total, and that practically all manufactured products are locally consumed. A study of water-borne commerce during the past 20 years reveals a gradual decline in both tonnage and value. In 1929, total tonnage on all the waterways of the capital amounted to roughly 2,340,000 tons. Of this total, sand, gravel, and stone accounted for 82 per cent; and petroleum products for 11.5 per cent. The remainder, approximately 150,000 tons, covers all other commodities, the greater part of which were handled by the facilities available on the Washington Channel.

The dilapidated condition of existing structures along the Washington Channel has long been a matter of concern to those interested in the beautification of the capital. Complete plans for its improvement have recently been submitted to Congress, but to date no action has been taken on the recommendations.

In the preparation of these plans, no attempt was made to provide facilities suitable for a large port. While Washington possesses many of the essential requirements of one, such a development has not occurred. The conclusion is inevitable that the growth of general commerce in Washington will be almost in direct proportion to the increase in population; that no radical change in quantity or type of commodities now carried can be expected; and that terminal facilities should be made on this basis.

Accordingly, railway interchange facilites were not provided. A pier and slip system was employed to utilize to the maximum the available frontage. Wharves will vary in length from 200 to 300 ft., and will have a total capacity of 608,000 tons annually. As present tonnage is only 150,000, these should be ample to meet prospective needs for many years to come. Provision has also been made to adequately handle and berth yachts—an item of some importance in the national capital.

Proper architectural treatment of wharf structures, to harmonize with the nearby Washington Barracks, has been secured by the use of brick and tile head-houses with slate on the parts of the roofs exposed to view. Obviously, such type of construction will be more costly than one based wholly on utility, but it seems to be well justified in a city which is spending millions annually for beautification alone.

As previously stated, of the many miles of waterfront, there is at the present time a total frontage of only 15,000 ft. available for terminal facilities. It is interesting to note the usage made of the remainder. Nine miles of possible navigation channel on the Anacostia River are being developed for park purposes; along the Potomac River, within the district and in the Washington Channel, $6\frac{1}{4}$ miles of potential commercial frontage are occupied by Potomac Park; $2\frac{1}{2}$ miles of frontage on an existing channel, with minimum depths of 15 ft., are occupied by Army and Navy flying fields; an additional 1.65 miles along the Potomac shore are to be devoted to the same

purpose; and nine-tenths of a mile along the Potomac is used by the Naval Experimental Station and includes the site of a proposed sewage disposal plant.

While this summary indicates that commerce and industry have been unduly handicapped by such extensive use of available frontage for other purposes, all reasonable needs have been met, and can be met in the future. An area of some size near the Navy Yard has been tentatively set aside for industrial development, and plans for the necessary railway trackage and storehouses have been prepared. The location will permit such construction without conflicting with the general plans for the beautification of the capital.

ANACOSTIA PARK, SECTION G, JULY 1929
Looking Upstream from Benning Road, with Present Approved Layout Superimposed

Some complaint has been voiced by commercial interests concerning the attempts which have been made to limit industrial growth on the Virginia shore of the Potomac. The exact boundary between Virginia and the District of Columbia has never been established. Because the courts have held that Maryland extends to the highwater mark on the Virginia shore of the Potomac, it has been contended that the District boundary is at that location.

The matter is now the subject of court adjudication, and on the outcome depends to some extent the success of the efforts being made to prevent development out of keeping with the structures being erected by the Federal Government. Congress has recently enacted a law providing for the establishment of a Memorial Parkway along the Virginia shore from Mount Vernon to Great Falls. Studies are now being made to effect a compromise which will reconcile conflicting demands, and devise a park plan which will not unnecessarily interfere with commerce.

This question of the District boundary has created a rather unusual situation with respect to the reclamation of Columbia Island within the District. So long as there is no land connection to shore, there can be no question of ownership and jurisdiction by the Federal Government. Therefore, a connection has never been made, and to prevent it by natural accretions, the Government has periodically dredged a separating channel approximately 50 ft. wide and 5 ft. deep.

One end of the New Arlington Memorial Bridge rests on this island. Because of this channel, it will be necessary to construct three bridges to accommodate traffic leading to the Memorial Bridge. One alone has cost in the neighborhood of one million dollars, which makes it appear that at least a more economical treatment would have been to settle these legal doubts by purchase, and to fill this channel, which is of no use to navigation.

Washington enjoys the rather unique distinction of having no single agency responsible for the administration and control of its waterfront property. As has been pointed out, ownership of the greater part is by the United States, but jurisdiction along the Washington Channel alone has been divided among three separate agencies: the Treasury Department, the Commissioners of the District of Columbia, and the Chief of Engineers, U.S. Army. Other portions of available frontage are administered by another officer, the Director of Public Buildings and Public Parks. And, in addition, proposed structures must secure the approval of the National Capital Park and Planning Commission. Prospective lessees may thus find it necessary to approach any one of four agencies. The creation of a single agency to administer and control all Government-owned water frontage appears desirable.

The water supply for the city of Washington is now secured from the Potomac. In spite of the extended drought of last summer there was no shortage, and studies indicate that the Potomac can be depended upon as an unfailing source of supply for many years to come.

Few appreciate the tremendous potential power resources of this stream, a great part of which are available at Great and Little Falls, just above the city of Washington. Studies recently completed reveal that an economically feasible and comprehensive development would produce approximately 1,400,000 hp., of which almost one-half would be secured from three plants in the vicinity of Great Falls. Certain elements have opposed this utilization of the stream because of its possible interference with a proposed park development. However, all interested parties should be familiar with the power possibilities of the stream, and at least know the costs, actual and potential, of the decision to be made.

The Port of Baltimore—Fourth in Tonnage

By WARREN T. HANNUM
LIEUTENANT-COLONEL, CORPS OF ENGINEERS, U.S.A.
DISTRICT ENGINEER, BALTIMORE

IN 1632, Cecil Calvert, Lord Baltimore, was granted by the King of England a charter for the colonization of the territory bounded by the 40th parallel, north latitude, and by two rivers now called the Potomac and the Delaware. An expedition of 300 colonists sent out by Lord Baltimore, under the leadership of his brother Leonard, in 1634 established the settlement of St. Marys on a stream (St. Mary's River) tributary to and near the mouth of the Potomac. Thus began the colony of Maryland.

BALTIMORE IN 1752

Baltimore was established nearly a century later. In 1729 the Maryland Assembly, in session at the capital, Annapolis, passed an act "for erecting a town on the north side of the Patapsco in Baltimore County and for laying out into lots 60 acres of land in and about the place where John Fleming now lives." These 60 acres, worth $600, have expanded in 200 years into a city having a population of approximately 800,000 within an area of 92 sq. miles, and having an assessed property value of approximately two billion dollars. Its growth has been gradual but persistent, and has been marked by a conservatism which still abides and is demonstrated in various ways. Although the city has been free from booms and their depressing after-effects, it has had its catastrophes, notably the great fire in 1904. However, the marks of this tragedy were so soon effaced that the event has become almost a legend to many of the inhabitants.

In the growth of the city, the Port of Baltimore, which antedates it, has been a major influence. The early planters found it such a handicap to have vessels enter and clear at the port of Annapolis, that they appealed to the Colonial Assembly, which in 1706 designated Whetstone Point, now Fort McHenry, as a port of entry. Until comparatively recent years, the port was confined mainly to the present inner harbor in the Northwest Branch of the Patapsco River, with its six miles of waterfront. But it has expanded with the city and today

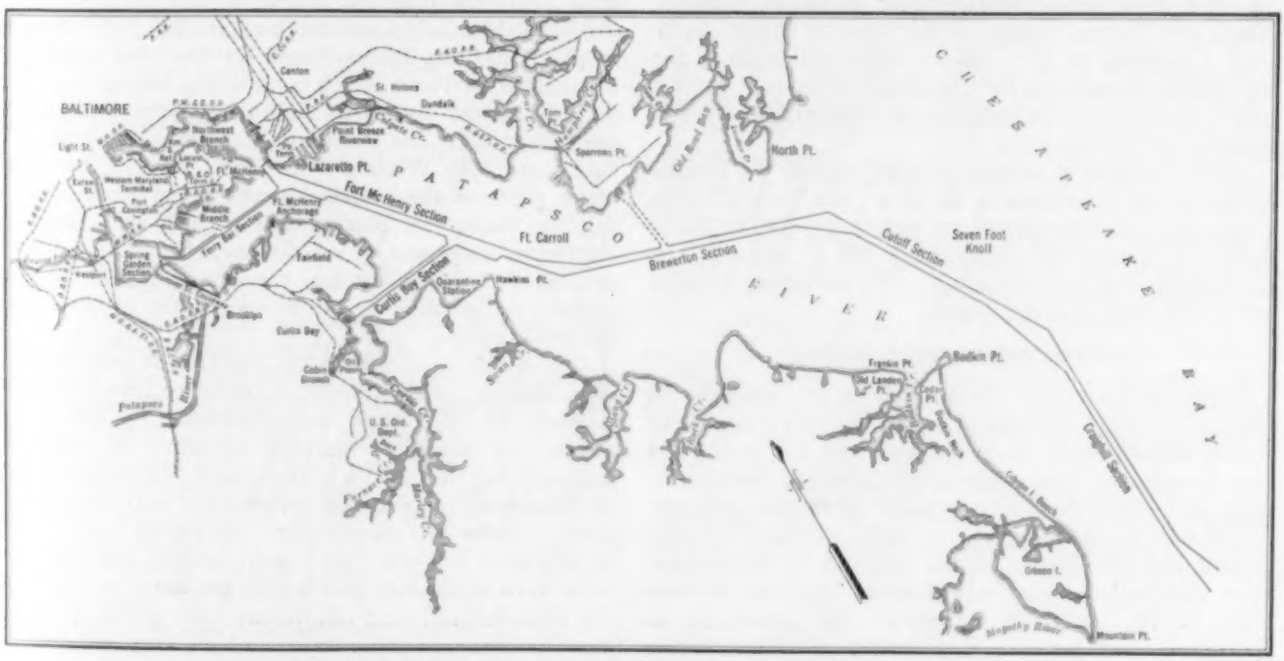


FIG. 1. BALTIMORE HARBOR AND CHANNELS AT THE PRESENT TIME

includes the Patapsco River and its tributaries, with more than 125 miles of waterfront, much of which is undeveloped. In 1750 the port provided berthing space, probably less than 1,000 ft. in length, at two wharves with less than 20 ft. of water alongside. Today it offers approximately 100,000 lin. ft. of berthing space for vessels drawing from 20 to 34 ft. The port's total

LOCUST POINT TERMINAL
The Baltimore and Ohio Railroad

commerce has increased from 4,800 tons in 1795, to more than 20,000,000 tons.

LIMITS AND SUBDIVISIONS OF THE PORT

The Port of Baltimore, as defined by state legislative enactment, consists of the Patapsco River and its tributaries. Its limits and the parts into which it is subdivided may be seen in the map, Fig. 1. Extending from Fort McHenry to within four blocks of the center of the city, the Northwest Branch of the Patapsco River forms the principal part of the harbor. Jones Falls, a small stream, supplies the only fresh water to this section. Pataspco River proper extends from its mouth, between North and Bodkin points, to the Hanover Street causeway, a distance of $11^1/_2$ miles. Other subdivisions are the Middle Branch and the Curtis Bay sections. Several other tributaries of the Patapsco are susceptible of development, should necessity arise.

Of the 37 miles of waterfront lying outside the bridges spanning the tributaries of the river, the United States Government has developed 1.8 miles; the city of Baltimore, 2.8 miles; the railroads, 5 miles; industries, 9 miles; and shipyards, 2.8 miles. The remaining 15 miles are as yet largely undeveloped.

FACTORS INFLUENCING GROWTH

Baltimore is situated 170 miles from the entrance to Chesapeake Bay. It may be surprising that a large port should develop so far from the seaboard, but it appears that deep-water transportation will generally seek an inland port whenever the approach offers free and unobstructed navigation and the port provides shipping service and distribution of the cargo to its destination more economically and expeditiously than can be had close to the seaboard. However, the industries of Baltimore itself have a considerable influence on the movement of water-borne commerce to and from it.

The streams discharging into the harbor drain such small areas that the amount of sediment they carry has no appreciable shoaling effect in its deep portions. The waters of the port are tidal; the mean range of the tide in Baltimore harbor is 1.2 ft., and in the lower bay, 2 ft.

The tidal current at strength varies in velocity from one-half knot in the Patapsco River to $1^1/_2$ knots in the lower bay. Thus the delay due to adverse current conditions is not such as to cause a ship approaching the capes materially to modify its speed in order to avoid an adverse tidal current in the bay. In addition, there are none of the disadvantages experienced by ships lying at berths where the range of tide is considerable.

The port is open throughout the year. Only in the most severe winters are its waters frozen, and at such times municipal ice boats keep the channel open. Fogs occur mainly from October to March, when they are dense for about 12 days on the average. However, the deep waters of the Chesapeake, with a minimum width of two miles, and the absence of isolated shoals, permit reasonably safe navigation up to the entrance of the dredged channel off the mouth of the Magothy River.

Conditions in the city are conducive to contented labor. The chairman of the board of the American Sugar Refining Company has stated that, "Nowhere in America, as far as I know, are the living conditions for every man, woman, and child as comfortable and as inviting as those provided in Baltimore." One of the inducements leading to the location on the Baltimore waterfront of the $30,000,000 plant of the Western Electric Company, eventually to employ 30,000, was the availability of intelligent labor. Strikes along the waterfront, resulting in serious interruption to shipping, are almost unknown.

INTERIOR AREA TRIBUTARY TO THE PORT

An analysis of the commerce of recent years shows that 38 states and Canada send or receive freight through this port in foreign or coastal, including intracoastal, trade; but the principal source of this commerce lies east of the Mississippi and north of the Ohio and Potomac rivers. Ohio and Pennsylvania are the chief contributors. This territory, which is naturally tributary to the port, is served by three railway systems with their connecting lines, the Baltimore and Ohio, the Pennsylvania, and the Western Maryland. Among the five major ports of the North Atlantic—New York, Philadelphia, Baltimore, Boston, and Norfolk—in general, Baltimore lies closest by rail distances to localities in the area west of a straight line connecting Baltimore and Buffalo, and north of the line formed by the Potomac and the Ohio rivers.

This situation is reflected in rail freight rates on foreign, coastal, and intracoastal traffic to and from this section. In 1877, there was established by agreement among the trunk-line railroads operating between the seaboard and the interior of the United States, a schedule of differential rail rates as between the various Atlantic ports. Under this arrangement, the export rate by way of Baltimore is 3 cents per hundredweight less than via New York or Boston, and 1 cent per hundred less than via Philadelphia; and the import rates are from 3 to 8 cents per hundred under those via New York and Boston. Although attacked on numerous occasions before the

Interstate Commerce Commission, these differentials have been sustained, and have a major influence on the routing of such traffic.

In addition, for the development of truck transportation, there are not less than seven well paved highways radiating from the city to the northwest and south, and there are no serious natural obstacles to the development of additional arterial highways in these directions as trade may demand.

SHIPPING FACILITIES

Satisfactory communications and favorable overland freight rates do not alone develop commerce. There must also be efficient and economical shipping facilities and water transportation service to and from the port. All four railroads, including the local Canton Railroad, now owned by the Penn Road Corporation, have overseas railroad terminals.

For grain storage, all except the Canton Railroad have a waterfront elevator with a capacity of approximately 4,000,000 bu.; and a coal pier with loading capacities rated at 54,000 tons in 10 hours, for the Baltimore and Ohio; at 6,000 tons in 10 hours, for the Pennsylvania; and 45,000 tons, for the Western Maryland. Two, the Pennsylvania and the Canton, have each an ore pier. The Canton pier is the more important, having a length of 1,000 ft., a depth alongside of 35 ft., an unloading capacity direct to cars of from 400 to 500 tons per hour, and a concrete storage bin with a capacity of 10,000 tons. At all these piers, which have depths of water alongside up to 35 ft., more than 100 vessels may be loaded simultaneously.

PORT OF BALTIMORE—FOURTH IN TONNAGE

The following shows the relative standing of the country's ports for the calendar year 1929, as reported in the statistical records of the Chief of Engineers:

TOTAL COMMERCE FOR 1929

RATING	PORT	TONS
1	Port of New York, including 30 localities in and near New York City	137,231,861
2	Port of Philadelphia, the Delaware and Schuylkill rivers, including Camden, N.J.	30,252,422
3	Los Angeles (inclusive of about 20,000,000 tons of petroleum)	29,106,095
4	Port of Baltimore	20,264,165
5	Port of Boston	19,065,050
6	Norfolk Harbor	17,843,950
7	San Francisco (exclusive of other San Francisco Bay ports)	17,604,709
8	Port of New Orleans (exclusive of 17,900,000 tons of local ferry traffic)	15,995,374
9	Port of Houston, Tex.	13,917,953
10	Beaumont, Tex.	12,004,725
11	Seattle	10,117,554
12	Portland, Ore.	9,776,211

For the unimpeded development of a port, other characteristics being favorable, it is essential that the channels to and within it shall have dimensions adequate for the density and draft of the vessels serving it. During the first hundred years of Baltimore's history, owing to the moderate draft of the sailing vessels then in use, there was no difficulty in reaching the city by natural channels, which afforded depths of from 16 to 18 ft. at mean low water. As the comparative economy of transport in larger vessels became apparent, it likewise became evident to the citizens of Baltimore that greater depths of water would be required in the ship channels of the port in order to retain and increase its overseas trade.

Beginning in 1798, the city expended modest sums annually for the maintenance and improvement of its harbor. The first Federal appropriation, of $20,000, was made in 1836, followed by $15,000 in 1837, and probably by other allotments for several succeeding years. With these funds a steam dredge was purchased and used to dredge the harbor in the Northwest Branch

PORT COVINGTON TERMINAL, LEASED TO THE WESTERN MARYLAND RAILWAY
Constructed by the Port Development Commission of Baltimore at a Cost of $8,500,000

in cooperation with the city. There was, however, no Federally approved project for the improvement of this section of the harbor until several years ago when Congress authorized its maintenance at 35 ft. at Federal expense as the city improved it to that depth, but the city has not yet turned over any part of it for maintenance.

FIRST FEDERAL IMPROVEMENT PROJECT FOR BALTIMORE HARBOR

By the middle of the century it became necessary to increase the depths in the ship channels through the Patapsco River to and through the bar at its mouth. In 1852, Congress made an appropriation for the purpose, and Captain Brewerton, of the Corps of Engineers, was placed in charge of the work. After consultation with those interested, he recommended dredging a channel 150 ft. wide and 22 ft. deep at mean low water from the city line across the mouth of the Northwest Branch to the same natural depth of water in Chesapeake Bay. These recommendations were duly approved and formed the first Federal project for the improvement of Baltimore Harbor.

This channel consisted of two sections, one extending in a straight line from the city line at Fort McHenry to a point $1\frac{1}{2}$ miles below Fort Carroll, and the other, in a straight line from the fort to the old ship-channel entrance buoy, $4\frac{1}{2}$ miles beyond North Point. With the exception of the last-mentioned section, which has been reduced in length, the location of the sections has remained unchanged and their dimensions have, from time to time, been enlarged.

The 22-ft. project was never completed, for in 1872, work was begun on a revised plan. This project, authorized on June 10, 1872, provided for a channel 24 ft. deep and 250 ft. wide from Fort McHenry to water 24 ft. deep at the lower end of the Craighill Channel, except that through the hard bottom in the channel a width of 400 ft. was provided. From 1872 to 1874, Congress

appropriated $375,000, and the city of Baltimore, $350,000 for excavation according to this plan. These funds permitted progress to be greatly accelerated and resulted in decreased costs of dredging.

Early in the summer of 1872, work was commenced "with a total of 13 dredges, 3 of them being of the clamshell type, and forming altogether probably the largest force of dredges ever employed in this country at one time on the same improvement." In two years, by June 1874, the practical completion of the project was reported, more having been accomplished in 2 years than had been accomplished in the previous 20 years.

In 1881 Congress adopted a new project for the improvement of the channels and made an initial appropriation for its execution. Under this project the depth was increased to 27 ft. and the width to 600 ft. through all sections, with a maximum width of 1,200 ft. at the angles. The cut-off section was included in the project and work was begun there in 1881. Due to the limited sums of money appropriated, the project was not completed until 1892, eleven years later. Today, 40 years after the completion of the 27-ft. project, the authorized width of the channel remains the same, 600 ft. The depth was successively increased under congressional authorization as follows: to 30 ft. in 1896, completed in 1905; and to 35 ft. in 1905, completed in 1909.

Thus, to meet the requirements of commerce, in the last 80 of the 225 years of the existence of the port, the original ship channel has been increased from 22 ft. to a minimum of 35 ft. in depth; from 150 ft. to a minimum of 400 ft. in width; and from 15 to 28 miles in length.

PRESENT FEDERAL PROJECT FOR IMPROVEMENT

The present Federal project for improvement and maintenance provides for:

1. A main channel between Cape Charles, Va., and Fort McHenry, Baltimore, Md., with dimensions as follows: 37 ft. deep and 1,000 ft. wide between the curves of the 37-ft. depth in Chesapeake Bay opposite York Spit, a distance of about 4 miles; 37 ft. deep and a general width of 600 ft. from the 37-ft. curve in Chesapeake Bay at the entrance to the Craighill section to the west side of the main private channel to Sparrows Point, a distance of about $12^1/_2$ miles; and 35 ft. deep and 600 ft. wide thence to Fort McHenry, a distance of about $7^1/_2$ miles.

2. A branch channel with dimensions as follows: 35 ft. deep and 400 ft. wide from the main channel to the head of Curtis Bay, a distance of about $2^1/_5$ miles; 35 ft. deep and 400 ft. wide from the main channel at Fort McHenry to Ferry Bar; and 27 ft. deep and 250 ft. wide from there to the Western Maryland Railway bridge, a total distance of about $3^1/_8$ miles.

3. Widening of the angle between the Fort McHenry and Ferry Bar sections.

4. Anchorages with depths of 35 ft. of water, which cover an area of $23^1/_2$ acres.

RELATION OF COST TO ANNUAL COMMERCE

Until about 1892, when the 27-ft. ship channel was completed, the city participated in the execution of the various projects adopted by the Federal Government. In addition, it has practically independently improved the inner harbor in the Northwest Branch, enlarging the channel from its original natural depth of 17 ft. at the entrance to 35 ft., and from less than 12 to 24 ft. at its upper end. It has also made improvements in other sections of the harbor outside the limits of the Federal projects.

In this work, the city has expended about $4,000,000. The United States has expended on the various projects adopted by Congress approximately $10,000,000. The total expenditures on the improvement of the harbor and the approaches to it have thus been approximately $14,000,000. Interest on this sum, at 4 per cent, amounts to $560,000 per annum. The maintenance of the improvements costs about $200,000, making the total annual carrying charges $760,000. If this sum were assessed against the commerce of the port, the annual carrying charge would be 3.3 cents per ton, an amount so small as to have practically no influence on the subsequent value of the cargo affected.

The Port of Hampton Roads

By J. GORDON BOHANNAN
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PETERSBURG, VA.

CONSIDERATION of the early history of Virginia serves as an excellent background against which to view the modern Port of Hampton Roads. That sturdy band of Englishmen who set sail from Blackwell on the Thames in December 1606, to found the first permanent English settlement in America, came, after five months, to "the mouth of a goodly bay," the "Mother of Waters," which was described as the "one entrance into this country." Their first landing was made on the southern shore of Cape Henry. But for the instructions which they had received, that they were not to locate near the coast lest they fall victims to the Spanish fleet, the settlement might have been founded on the shores of this harbor rather than further inland at Jamestown.

The Colonial Government soon realized the necessity for the establishment of ports where ships might "unload and put on shore and take from shore to load on board tobaccos, goods, and merchandises." Accordingly, in 1631, just 300 years ago, it was provided that "every shipp arriving in this colony from England or from any other parts, shall, with the first wind and weather, sayle up to the Porte of James Citty" (Jamestown).

Later, other ports were established for the several counties, as settlements sprang up along the navigable streams—one in Elizabeth City on the west side of Hampton River and one in "Lower Norfolke County"—and

ships were required to load and unload their cargoes at these ports. The building of towns and the building of ports proceeded together. Among those towns desig-

NORFOLK TIDEWATER TERMINALS, INC.
One of the Most Complete Terminals in the United States

nated as ports were Hampton, on the northern side of the port area, and Norfolk on the southern.

And so, in the early years of Virginia's history, while it was still a colony of England, the advantages of this port were recognized—its strategic advantages for defense, and its commercial advantages for the carrying on of trade.

Save for the effects of the ravages of time, the "Porte of James Citty" looks much as it did in 1607. The first customs house established in the United States still stands at historic Yorktown—incidentally, once a port of entry for New York City. But entrances and clearances within the Port of Hampton Roads are now made through the port cities, Norfolk and Newport News. The "Ffort at Point Comfort" has become one of the

THE FIRST CUSTOMS HOUSE IN THE UNITED STATES
At Yorktown, Va.

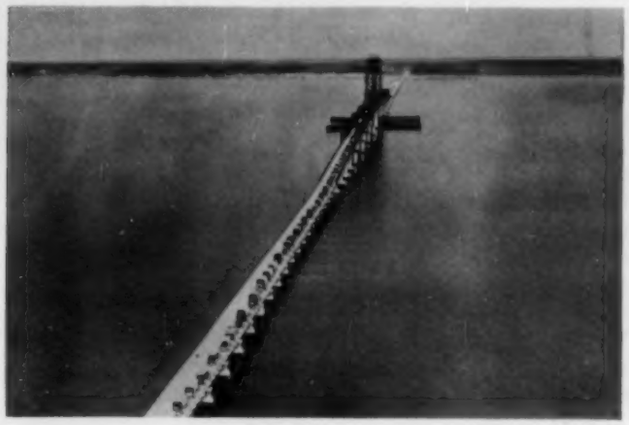
chief coast defenses of America and, with Fort Story at Cape Henry, protects the entrance to the bay.

Recognizing the climatic and other advantages of this area, in recent years the United States Government has located other military and naval establishments within the port area of Hampton Roads, including the Norfolk Navy Yard, the headquarters of the Fifth Naval District, the Naval Hospital, the Marine Hospital, the Naval Ammunition Depot, the Army Supply Base, and Langley Field.

A PORT THREE HUNDRED YEARS OLD

To the port cities of other days, Norfolk, Portsmouth, and Hampton, has been added the thriving city of Newport News, at the mouth of the James River. Scattered settlements along the shores of the bays and streams have grown, and the area has become the home of more than 300,000 people.

The industrial development of Virginia during the



THE JAMES RIVER BRIDGE
$4\frac{1}{2}$ Miles Long, Between Newport News and Norfolk

past few years has been exceedingly gratifying. Possessing in a large measure the essentials of industrial growth—fuel, adequate labor supply, raw materials, favorable climate, proximity to world markets, and unexcelled transportation facilities—Virginia has attracted new industries, and the value of the output of her factories has increased during the last quarter of a century from a scant 150 million to more than a billion dollars. The increase in capital invested in industry has been commensurate with the output.

MODERN FACILITIES

Warehouses and wharves of other days, suitable for the modest needs of the period, have given place to modern piers of reinforced concrete construction, with transit sheds and supporting warehouses designed for the shipment or storage of special or general cargoes. Cold storage and ventilation facilities are provided. Each of the railroads serving the port operates its own waterfront terminals. In addition to these, there are numerous terminals owned and operated by steamship lines, individuals, and private corporations. Modern coal piers, electrically operated—one with a capacity of 7,200 tons per hour—have been built by the three great coal-carrying roads, over which nearly 20,000,000 tons of coal were dumped last year for bunker or for shipment in coastwise or overseas trade. Grain elevators have been erected on both sides of the port, one having a capacity of 1,000,000 bu. and another with that of 750,000 bu.

The limitations on shipping imposed by shallow depths

of water have been removed. A 40-ft. channel ranging from 450 to 700 ft. in width, leads from the Virginia Capes to the Norfolk Navy Yard on the Southern Branch of the Elizabeth River; and a 40-ft. channel to Newport News, 700 ft. in width and expanding to 1,000 ft. at the approaches, is nearing completion. The combined waterfront of the port is approximately 50 miles, of which about 30 miles have been improved.

In place of the dirt roads, over which hogsheads of tobacco were once rolled down to the port and lumbering wagons hauled their freight, modern highways have been constructed. Eight trunk-line railroads now enter the port, seven having their terminals in Norfolk or Portsmouth, and one in Newport News.

REGIONS SERVED

The Atlantic Coast Line Railroad serves the coastal plain sections of the Carolinas, Georgia, Florida, and Alabama. The Chesapeake and Ohio, with its terminals in Newport News and its car-float and ferry service to Norfolk, connects the port with the West Virginia coal fields and the great agricultural and industrial area of the Middle West. The Norfolk and Southern extends into North Carolina, connecting with other carriers at Wilson, Raleigh, and Charlotte. The Norfolk and Western brings to the port the coal from the Pocahontas Coal fields of Virginia and West Virginia and extends to Cincinnati, Columbus, and to other cities of the great Middle West.

The Pennsylvania reaches Norfolk by car ferries to its new terminals at Little Creek, on the southern shore of the Chesapeake Bay, and by passenger steamers from Cape Charles. From Little Creek it extends its service into the North and West. The Seaboard Air Line reaches southward into the Carolinas, Georgia, Florida, and Alabama. The Southern Railway serves a vast area throughout almost the entire South. The Virginian, primarily a coal-carrying road, has greatly increased its potential trade area through its connections with the New York Central, recently effected.

These eight railroads, with the switching facilities offered by the Norfolk and Portsmouth Belt Line Railway, every day load approximately 300 cars of package freight for distribution throughout the South, the West, and the North.

The tramp ships of comparatively few years ago, which called at Hampton Roads when and if cargo was provided, have given place to more than 50 overseas cargo lines, providing regular and frequent sailings to many of the principal ports of the world. The sailing list for April shows 14 separate sailings to the Far East, by 9 separate steamship lines. A sailing schedule for passengers and freight to Havre and Hamburg becomes effective in July 1931.

The opening of the Panama Canal provided the port with an excellent coastal service, an average of 14 outbound sailings every month by 4 steamship lines. Coastwise, bay, and river services connect the port with the principal cities of the East and with the commercial and agricultural areas located on the tributary waters.

Tobacco is among the principal exports, the amount shipped from the Port of Hampton Roads exceeding the combined tonnage from all other American ports. Of the total export tonnage of leaf tobacco, 70 per cent goes out of this port. Cotton, cotton piece goods, lumber, agricultural machinery and implements, paper, grain, and grain products are included in the long list of exported articles. In 1929, the total export tonnage of Hampton Roads was over 2,500,000 and the freight moved to 80 separate trade areas. The tonnage of the port in the past has not always been well balanced, but imports are increasing in volume, value, and diversity. They include such articles as wood pulp, newsprint, hides, fertilizer materials, copra, and sugar. Because of superior warehousing facilities, large quantities of raw sugar are kept in storage and transshipped as needed to refineries located in other states.

REQUISITES FOR PORT DEVELOPMENT

In every worthwhile port development plan in operation today, the need for both physical and executive unification of terminal facilities is recognized. Some of the largest of our American ports are beginning to learn that efficiency in port operation is no longer determined by the size of the port or even by the natural advantages which it enjoys. Some of the best of the world ports have been dug out of the mud or have had their entrances blasted out of solid rock. Six of the most efficient ports in Europe might be set down bodily in the Port of New York.

SOUTHERN EXPORT STAPLES ON THE DOCKS AT NORFOLK
Tobacco Being Loaded for the Far East (Left), and Cotton Ready for Shipment (Right)

The problem of physical unification of terminal facilities within any port must be approached with due regard to the controlling physical facts, the geographical location, size of the port area, nature of the shore line, character of the waterways, depth and width of the channels, location and grouping of the various terminal units, the distance between them, their ownership and operation, and the needs of the port generally. The solution to this problem lies largely with the terminal engineer, and physical conditions will generally yield to his genius when it is supplemented by the necessary capital.

The problem of administrative or executive unification, although its solution is dependent in a measure on the elements which determine physical coordination, is not one of engineering only. It is concerned with more than the mere laying out and building of wharves, piers, warehouses, and docks, and the construction of bridges and tunnels, or the efficient grouping of terminal units. Its solution is made more or less difficult by the diversity of ownership or operation of terminal facilities, the provisions of state constitutions, the acts of state legislatures or of Congress, and the decisions of the courts, state and national.

The area of the Port of Hampton Roads, as defined by the General Assembly of Virginia, embraces the municipalities of Norfolk, Portsmouth, Newport News, Suffolk, Hampton, Phoebus, and Virginia Beach, the body of water known as Hampton Roads, the lower Chesapeake Bay, and about 15 miles of ocean frontage, extending from Cape Henry southward. Into Hampton Roads from the west flow the waters of James River, navigable for over one hundred miles, to the City of Richmond. The commercial importance of this river is recognized by the recent authorization of the expenditure of Government funds for its improvement. At the mouth of the James River lies the City of Newport News, on the northern side of the port area, which is the eastern terminus of the Chesapeake and Ohio Railway Company. Here are located piers and docks and deep-water terminals, and the Newport News Shipbuilding and Dry Dock Company, the largest privately owned shipyard in America.

Flowing into Hampton Roads from the north is Hampton Creek, and from the south, the Nansemond and the Elizabeth rivers. The Nansemond River provides an approach to the bay from the City of Suffolk, and the Elizabeth River, with its three branches, leads to the cities of Norfolk and Portsmouth, and the numerous docks, piers, wharves, and warehouses along their waterfronts. The Southern Branch of the Elizabeth River, together with the canals and other bodies of water which connect it to Albermarle Sound, forms an important link in the chain of waterways along the Atlantic coast.

Within the port area as defined by law, the piers, warehouses, and other terminal facilities are owned and operated either by railroads, steamship lines, corporations, individuals, municipalities, or by the United States Government. The State of Virginia neither owns nor operates any port terminal facilities within its port. The constitution of Virginia does not permit the state to contract debts for port development or to grant credit to or in aid of any person, association, or corporation owning or operating port terminal facilities; nor can the state subscribe to or become interested in the stock or obligations of any corporation for the purpose of aiding in the construction or maintenance of such works.

With the extension of the interchange service which is now provided on either side of the port area, so as to furnish better means of transportation of freight between the two sides, physical unification of all the existing terminal units will be greatly improved. This may be accomplished by the extension of belt-line facilities so as to include service over a railroad bridge or through a tunnel connecting the northern and southern shores of the port area, or by means of a unified and jointly owned or operated inter-port barge line or lighterage system, which itself might be an extension of the present belt line.

Improved highways—including the new highway bridge over the James River above Newport News, over four miles in length—enable motor trucks to effect transfers of freight within the entire port area. The increasing importance of transportation by air of mail, express, and non-bulk commodities as well as of passengers, makes complete physical coordination impossible without adequate provisions for suitably located commercial airports, with proper provisions for transfers between these and the water terminals.

In the introduction to the series of reports prepared by the Board of Engineers for Rivers and Harbors of the War Department, in cooperation with the United States Shipping Board, it is said: "When possible, the control of all deep-water frontage by the public, as represented by the state or by the municipalities, including the ownership and operation of a belt-line railroad connecting all the rail lines and all the terminals, is a practical solution of the coordination problem, and is an effective remedy for many of the ills that now exist."

STATE PORT AUTHORITY OF VIRGINIA

Out of this conception of its obligations, the Hampton Roads Port Commission was formed. From this commission the State Port Authority of Virginia evolved, as an agency of the state and as a body corporate. Subject to the lawful regulations and control of the United States Government over navigable waters, certain rights are conferred on this commission under the provisions of the act of the General Assembly of Virginia by which it was created, and certain duties imposed. Its powers are largely regulatory, and they are employed in the exercise of the best judgment of its members for the protection of public and private rights, and for the increase of the efficiency of the port in the extent and kind of service rendered.

A few years ago the people of Virginia outside the tidewater section manifested but little interest in the Port of Hampton Roads, except to admire its beauties and to enjoy its recreational facilities. Today they are thinking in terms of their state. They realize that certainly one of its greatest physical assets, if not its greatest, is the Port of Hampton Roads, and that the commercial and industrial prosperity of the state depends for its promotion on the fullest development of the possibilities of that port.

Port development is a progressive and continuous process. The plan as outlined, both as to physical and executive unification and control, will be changed as the powers of the state are enlarged or as the needs of the port are presented.

A Convict Road Camp in the Virginia Mountains

Convict Labor in Highway Construction

Virginia's Experience Proves Beneficial to the State

By Henry G. Shirley
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FOR 25 years Virginia has operated convict camps on county aid and state highway projects. Formerly, convicts were also hired to contractors doing state highway work, but since 1923 the State Highway Commission has directed the activities of all prison camps. In addition to the fact that highway construction is carried on at a greatly reduced cost to the citizens, 2,000 prisoners are taught to work while they are receiving their punishment. As Mr. Shirley stated before the Highway Division of the Society at the Norfolk Meeting, on April 15, 1931, probably no other line of endeavor for prison labor competes in so small a way with free labor.

SOME approach the subject of the use of convict labor in highway construction as reformers, with an exceedingly prejudiced viewpoint, believing that the opinions they advocate are the best for the prisoner and for society. Others hold just the opposite view and seek to exact from the prisoner every ounce of punishment that the law allows, with no thought of his welfare during imprisonment, or of qualifying him for a place in society when his term has been served. Without deciding which of these groups is right, I shall outline here in brief the work of the Virginia Department of Highways in handling prisoners on highway construction for the past quarter of a century, the efforts of the department to improve the condition of the convict, and the return made to the people of the state from his labors.

In 1906 the Virginia Legislature passed an act directing the State Highway Commissioner to place a convict force in various counties of the state to assist in road building. During October of that year the first force was put to work, and by the end of December there were five forces of about fifty men each in operation. The Superintendent of the Penitentiary and Prison Control Board had charge of the care, guarding, feeding, health supervision, and clothing of the prisoners, while the State Highway Commission directed the place and scope of the work.

This convict force was a form of state aid in county highway construction and, since 1906, it has been working on county and state roads. Originally consisting of 200 men, it has now been increased to 2,000. It was organized by Capt. P. St. J. Wilson, now Chief Engineer of the Bureau of Public Roads, Washington, D.C., when he was State Highway Commissioner. The arrangement was that the state should furnish the prisoners, and the counties should pay for their supervision, equipment, and other costs. During the early period of the convict work, the railroads of the state offered to transport these camps from one locality to another free of cost.

Since this form of assistance was preferred by many of the counties to money aid, the demand for it was far in excess of the number of prisoners available. It was also noted by the commissioner that the work was being done more cheaply than by free labor. In fact, the force was so successful that it was not long before a county-aid system of roads was established for the convict laborers to work upon.

When the state highway system was formed, the law provided that the State Highway Commission should use the convict force in the construction of state highways and that preference should be given to its use for that purpose. However, if the convicts were not so used, the counties had the option of taking them.

PRISON LABOR HIRED TO CONTRACTORS

For several years a portion of this convict force was hired to contractors doing state highway work, at the rate of 15 to 20 cents per man hour, and the contractors took all the camps which were available. The welfare of the convicts was under the Prison Control Board in regard to such matters as feeding and guarding, and the contractors were not allowed in any way to interfere with the actual management of the camps except to say how and where the prisoners should work. This plan was fairly successful until 1923, when contractors who were unable to secure these forces, complained that they were being discriminated against. The State Highway Commission then took over the entire force as a state organization and has since worked it as such.

The convicts are used on all types of construction. They do well on bituminous and concrete surfacing, but on light work, where a small amount of labor extends over a considerable distance, the question of guarding is more difficult and expensive.

Before being sent to the camps, the prisoners are carefully selected by the Superintendent of the Penitentiary. They are given a physical examination, and no prisoner not capable of doing manual labor is sent out. The men are put through an apprenticeship, during which they are prepared for the work they are to undertake. Over each camp is a camp sergeant, who has charge of the guarding, feeding, clothing, and medical and religious care of the prisoners.

The State Highway Commission has a superintendent who directs the road work under the resident and district engineer, and decides where and how the prisoners shall work. Sometimes the camp sergeant acts both as camp sergeant and superintendent. This arrangement proves satisfactory when a good man can be secured for the position. Excellent results are also obtained when a camp sergeant and a superintendent work in cooperation with each other. In fact, if the camp consists of a large number of men, operating much machinery, it is better to have the two officers. Realizing that, if the force is to work efficiently, it must be properly equipped, the state has supplied each camp with the very latest machinery and equipment, similar to that of a contractor's outfit, and it maintains and operates the camps along such lines.

AN ANALYSIS OF COSTS

A detailed account is kept of the cost of feeding, guarding, and clothing the convicts as well as that of operating the equipment. Various other items are included, such as depreciation, rental, and materials for each job. The daily cost per man is as follows:

ITEM	COST
Feeding	$0.27
Clothing	0.077
Guarding and personal service	0.225
Miscellaneous	0.183
Total	$0.755

This means an approximate cost of $275 a year to guard, clothe, and feed a convict and pay his other expenses. Exclusive of rainy days, the convict works on an average of 250 days a year which, at $1.50 a day, makes his value $375. Less the cost of upkeep, $275, this leaves an annual profit of $100 for each convict.

Detailed costs are kept for each item of the equipment, including rentals and the hire of free laborers who work with the convicts. Cross sections are taken and proper estimates made before the work starts, just as if it were to be done by contract. A full charge is made for everything that is put into the work, in addition to 15 cents

A CAMP COMPLETES FROM 8 TO 10 MILES OF ROAD A YEAR

an hour for the convict labor. When the work is finished, a new cross section is made, and an estimate is compiled to show exactly how much work has been done and what it has cost.

The cost of transporting the prisoners from the penitentiary to the convict camps and of caring for them is charged against a fund derived from the gas tax, and set aside for that purpose. No portion of the court's cost or of the transportation of the prisoner from the jail to the penitentiary is charged against the highway fund, nor is any sum paid the prisoner from this fund. However, the state provides a small fund out of which the prisoner can be paid each day so that he will have saved some money by the time he is released.

SUBSTANTIAL SAVING TO THE STATE

The commission estimates that each convict is worth $100 a year to the Highway Department, and that the 2,000 men are worth approximately $200,000 a year. However, the state also saves the cost of maintaining these prisoners in the penitentiary, which would be approximately $240 a year for each one, or $480,000 for the 2,000. This means a total saving to the state by working the convict force of about $680,000.

Portable camps are used, so that they can be taken down and moved from one location to another. The men are kept under strict discipline. It has been found

OUTLINE OF ORGANIZATION AND FACILITIES OF CONVICT CAMP

BUILDINGS
1 cell building
1 dining room and kitchen
1 guard house and office
1 storage room

GUARDS
1 sergeant
1 yard guard
1 night guard
5 road guards

ORGANIZATION OF CONVICTS
10 convicts on yard to cook, wash, and clean
15 convicts on wheeler outfit, driving, loading, dumping, and plowing
35 convicts in quarry
10 convicts crushing
15 convicts with steam shovel and driving
15 convicts cutting subgrade and spreading stone
15 convicts building culverts and clearing

EQUIPMENT
1 steam shovel outfit:
  1 steam shovel
  9 wagons
  27 mules
3 ten-ton rollers:
  2 on grade (on grade, tampers could be used instead of rollers)
  1 on surface
1 small concrete mixer on drainage structures
1 small tractor (3 to 5 tons) and road
1 small pump and engine
1 crushing outfit:
  1 crusher, 14 by 26-in. opening machine
  1 boiler and engine, 35 to 40 hp.
  1 bin, about 50 tons capacity
500 ft. of track
4 quarry cars, 1½ cu. yd. in capacity
1 hoisting engine or drum
1 sprinkler, 500 gal., on small truck
8 three-ton trucks
1 light truck for general service
1 blacksmith outfit
1 set mechanic's tools for light repairs
1 complete outfit of small tools
1 wheeler outfit:
  9 wheelers
  27 mules
2 air compressors (each compressor operating 3 drills):
  1 on grade
  1 in quarry

SUPERVISORY STAFF
1 superintendent
1 cost-keeper
4 foremen
1 carpenter foreman
1 blacksmith
1 mechanic
1 shovel operator
3 roller operators
1 tractor operator
9 truck drivers

that much more work can be done and that the convicts are more efficient if they are well fed with good substantial food and fresh vegetables. This food item has increased in importance from year to year, until the menu

TEMPORARY MOVABLE CAMP

for the camps is now similar to that in any contractor's camp or in the army—well balanced and of good quality. A typical convict camp consists of from 100 to 115 men. The organization and facilities of such a camp are given here in outline.

Where grading consists of 18,000 to 20,000 cu. yd. to the mile, a typical convict camp such as the one outlined should build from 8 to 10 miles of surfacing and grading a year. The whole force of 2,000 men does about $4,000,000 worth of highway construction annually. Approximately $550,000 is expended on the convicts, the balance going for such items as additional free labor, rental for equipment, materials, and supplies.

These figures represent the monetary benefits directly received by the state in using convicts for the construction of highways. But there are other advantages which cannot be measured in terms of dollars and cents. For one thing, it would be a very serious matter if these 2,000 convicts had to be returned to the penitentiary, for its capacity is only between seven and eight hundred prisoners, and this number is already confined there. The prison farm has from eight hundred to a thousand men, and would not have facilities to take care of the additional 2,000 now working on the highways. Also, if these men were confined without work to do, there would be riots and such outbreaks as have occurred in other institutions where large numbers are confined without adequate provision for keeping them occupied. There has been no such outbreak in Virginia, and it is believed that, by keeping the men separated into small groups and busily engaged, there will be none.

The saving to the state of approximately $680,000 will offset the expense of operating the courts, but this is only a small factor when compared with the actual good done the prisoner during the time spent on construction. The Prison Control Board has a rule that each prisoner must be able to read and write and must have gone at least as far as the fourth grade. If he does not know how to read or write when he enters the penitentiary, he is taught intensively until he is capable of doing so. If he wishes to continue his studies further, provisions are made so that he can do so. In fact, there are a number of instances in which men have studied professions while they were imprisoned and entered them upon finishing their sentences. For example, a man was recently admitted to the bar after passing the bar examinations, for which he did much of his studying while confined as a prisoner.

BENEFIT TO PRISONER A CONSIDERATION

It is the opinion of the Superintendent of the Penitentiary and of others who closely supervise the working of the convict camps, that many of the prisoners become very efficient in certain lines of work and are capable of getting good jobs when their terms expire. They go back into society equipped to make an honest living and to become good citizens. The records of the prison show that a large percentage of prisoners released do this, and it is worth a great deal to the state to have a criminal turn into a law-abiding citizen. This alone more than pays for the working of the convict force, and it would be a great calamity if the large number of persons confined in the various penitentiaries were deprived of the opportunity to work and improve their physical and mental condition while serving their terms.

My opinion, which is supported by many prison authorities, is that it is essential to keep a prisoner employed. He should be given an interest in some kind of work and thus qualified to earn a living when his term expires. National and state laws are being passed which restrict the usefulness of the prisoner and the output of prison-made goods, and this tendency is most detrimental to the welfare of both the prisoner and the public.

INTERIOR OF A DINING ROOM AND BUNK HOUSE

While working on the highways, the convict encounters competition in a smaller way than in almost any other line of endeavor, and this work is a valuable experience for him. The law sentencing the prisoner provides that he shall work while in prison and, in some instances do hard labor. Yet there are other laws being enacted to defeat this object by restricting his field of activity.

I do not wish to be misunderstood as in favor of an inadequate punishment for the crimes committed against society. But while the prisoner is receiving his punishment he should be taught to work and thus to earn an honest living, so that, on his release, he will not continue to be a menace and a burden to society.

TYPICAL MISSISSIPPI LEVEE AND CROSS SECTION

Flood Control and Channel Maintenance on the Lower Mississippi River

By LYTLE BROWN
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THE first men of white blood to explore the Father of Waters, or the Mississippi River, were the French, who came from Canada by way of the Great Lakes and made a trail that has been traveled ever since. In 1718, New Orleans was established by Bienville, who wanted to be as near as possible to the sea, and found a place on firm ground only after a hundred miles of struggle against the powerful current of the great river. The water was there in a great stream over a half mile wide and a hundred feet deep, but the land was not so favorable. Then began the struggle against the floods of the Mississippi.

Very little work was required at first for flood protection and none at all for navigation. There was plenty of opportunity for the water to get away. Above extended a thousand miles of low banks, easily topped, and endless level bottom lands over which it might spread. It could go to the Gulf by many routes outside the usual one of ordinary stages. Only a low bank of earth knee high was needed to give protection to the new little settlement that was called New Orleans.

The building of levees progressed as the lands along the river were taken up, each man protecting his own. The natural process of building up the alluvial lands made the ground highest at the river banks and left the lower land some distance from the river. As the settlement spread up the river, it was required by law that every man do his part on the river front against the water. Thus, in the course of years, the river was deprived of the great natural reservoir of its bottom lands and of the drainage facilities provided by the low ground which ran parallel to it some distance away.

As the levee system was extended, the flood waters were more and more confined, and it became necessary to raise the height of existing levees. In fact, levee building soon passed beyond the scope of the individual plantation owner. Levee districts were then organized under state control, but state authority could reach only to the confines of the state, and thus there appeared cause for the intervention of the Federal Government.

The difficulties which arose in getting Federal appropriations for levee building were overcome on the ground that the maintenance of a navigable channel in the river was related to the confinement of flood waters to the natural channel. The truth of this theory has not been demonstrated, but it may still stand for it has not been definitely proved to be in error.

Since 1850, the Federal Government has taken an active part in flood control work on the Mississippi River. In that year the Government-owned lands along the river were given to the states in order that the proceeds from them might be devoted to the work of flood protection. This legislation was known as the Swamp Act.

PRESENT plans for Mississippi flood control are based on a flood of 3,000,000 sec-ft. at and below Old River, estimated to occur once in 200 years. At Old River such a flood is to be divided equally between the Mississippi and the Atchafalaya. To protect New Orleans, 250,000 sec-ft. is to be diverted into Lake Pontchartrain through the Bonnet Carre Spillway, just completed. As a part of this program, levees are being moved back bodily and their banks extensively protected with mats. In this abstract of his paper presented before the Technical Session of the Society, on April 15, 1931, at the Norfolk Meeting, General Brown outlines the present plan, which provides protection solely by means of levees and controlled diversions, studies of detention reservoirs having so far proved disappointing because of the excessive costs involved.

About the same time, the War Department through its engineers began the study of the flood problem. After a brief study, Charles Ellet made a report on the situation in which he introduced the idea of building reservoirs on the watershed and also that of providing diversions from the main channel. Shortly after, Captain Humphreys and Lieutenant Abbot undertook a very complete ten-year study, one of the most exhaustive that has ever been made on such a subject. There were no rainfall data for the watershed and no comprehensive gaging of the great tributaries. As the basis of protection work, they were obliged to take one flood, that of 1858, for which it was practically impossible to obtain a correct estimate of outflow. The best estimate they could obtain of the total amount of flood water that would have to be taken care of was about one-half that of the 1927 flood.

Their calculated outflow at the latitude of Red River Landing was less than 1,500,000 sec-ft., as compared with 2,350,000 for the 1927 flood, and 3,000,000 for the maximum probable flood. As a result of their study, they recommended a system of levees, with a possible minor diversion of about 100,000 sec-ft. on the west side of the river into the Tensas Basin.

Considering the large error in their fundamental data as to the size of flood flows, it is not strange that Humphreys and Abbot concluded that levees alone could be built economically to restrain a large flood. It is significant that these early investigators contemplated a diversion of flood waters out of the leveed channel even during an underestimated flood flow. They considered reservoirs for flood control and rejected them rather summarily on the ground that storage in sufficient quantity was not obtainable. Large diversions were discarded because of considerations of expense.

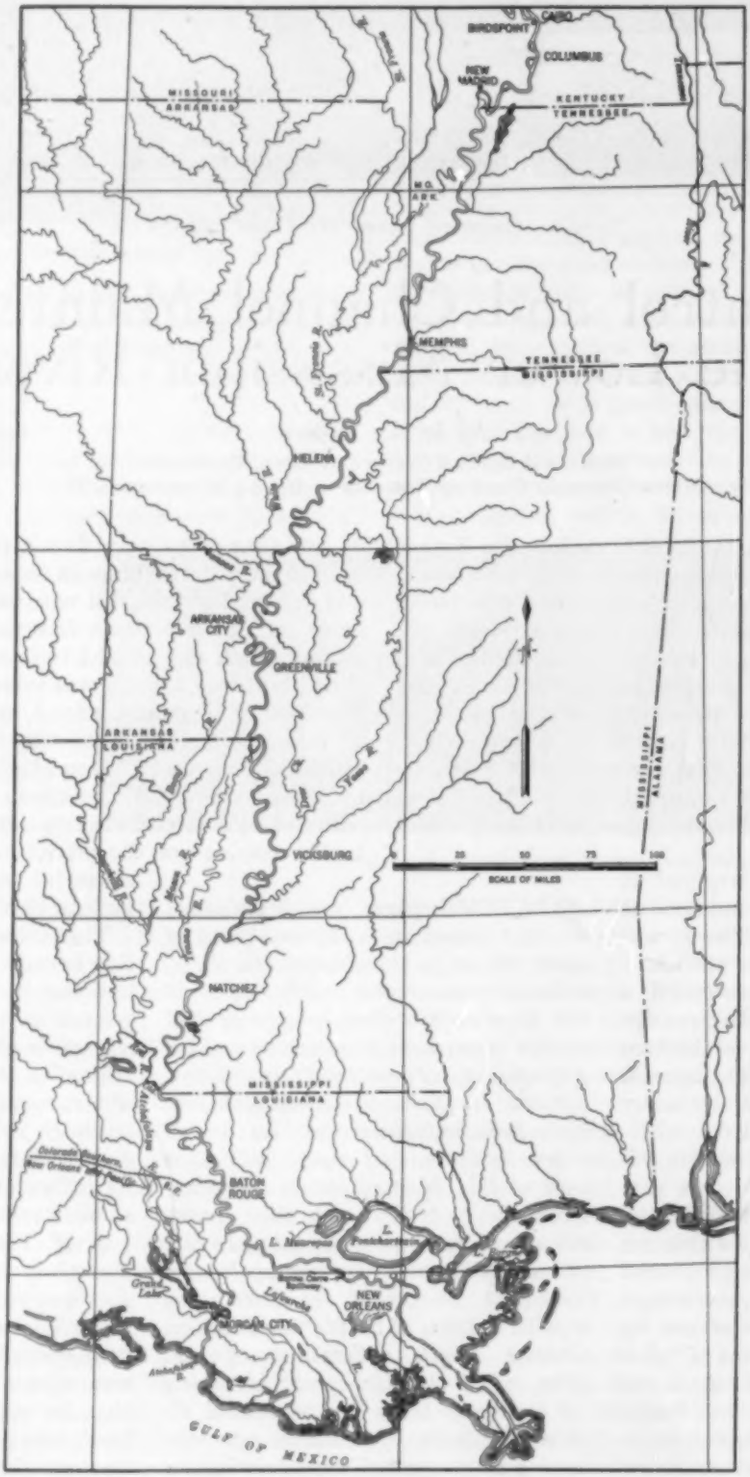


FIG. 1. THE MISSISSIPPI RIVER BATTLE FRONT

MISSISSIPPI RIVER COMMISSION FORMED

In 1879, the Mississippi River Commission, a Federal agency, was created to coordinate the work of flood control. This it does through its use of the Federal funds placed at its disposal. A steady improvement in flood conditions on the river since the commission began its work has been the result. Under the present arrangement, the commission is directed by the Secretary of War and the Chief of Engineers, who, in turn, is guided by the advice of the commission.

SOURCE OF FLOODS

The great extent of the Mississippi watershed, which embraces some 1,240,000 sq. miles, is in accord with the magnitude of its floods. Those of extraordinary magnitude are caused by heavy rainfall occurring along the various tributaries in such sequence as will bring their waters together on the same flood crest, or approximately so. The Ohio is the greatest contributor, and is dangerous at the same or about the same time as the Arkansas. Together these two rivers are the source of the greatest flood menace; they were largely responsible for the flood of 1927. Ordinarily, the Missouri and the upper Mississippi come in late with their contribution of melted snow.

Fortunately, storms usually strike the lower river first and sweep up the valley, giving a chance for the

crests of the lower tributaries to get out of the way. The reversal of the direction of storm travel would increase the probability of conjunction of crests in the main stream. If widespread rains are frequent through the fall of the year and the channel becomes well filled before winter, then the conditions are right for a great flood in the spring.

MAXIMUM PROBABLE FLOOD

Records of gage heights and discharges provide the data from which is determined the maximum probable flood against which protection should be secured. Gage heights are more generally available, and cover longer periods, than actual stream gages. Neither the determination of stream discharge at over-bank stages nor the connection of gage-height data with actual discharge in the stream are precise operations, and even when the discharge finally is obtained, the gage heights at various points on the stream cannot be exactly computed.

The Mississippi River Commission estimated the probable maximum flood at Cairo at 2,250,000 sec-ft., a flood about 25 per cent greater than that of 1927, a factor of increase that is relatively high for a drainage area of 894,700 sq. miles. This flow, plus such contributions as were made by the St. Francis, the White, the Arkansas, and minor tributaries during the flood of 1927, less storage, would produce at Arkansas City a maximum of 2,850,000 sec-ft., and (with 170,000 sec-ft. from the Red River and 80,000 sec-ft. from the Ouachita, less storage) a maximum outflow of 2,650,000 sec-ft. at the latitude of Old River.

At and below Old River the maximum discharge was assumed, more or less arbitrarily, at 3,000,000 sec-ft. After maximum stages were estimated for a confined flood, reduced stages were computed for such a flood under the assumption that flood waters would escape at the mouth of the Arkansas and the head of the Atchafalaya Basin. Records of stages along the river when waters were escaping at these locations indicate what stages may be expected if such a maximum flood ever occurs.

REQUIREMENTS OUTLINED

The main river levee grade of the adopted project was fixed at 1 ft. above the estimated maximum flood stages. In view of the improbability or infrequency of such a flood, it was considered that the factor of safety adopted —equivalent to about a 3-ft. freeboard for a flood like that of 1927—was ample for the present. If experience indicates the advisability of a greater freeboard in certain localities, it can be provided at some future time.

Four important points were clearly recognized in the plan adopted, as follows:

1. The size of the probable maximum flood should be taken as much larger than that planned for in the past. The discharge at the latitude of Red River Landing is estimated to be 3,000,000 sec-ft.
2. Levees to confine the maximum probable flood would be too costly and to hazardous.
3. The necessity of giving practically certain protection to centers of population like New Orleans, Greenville, and Cairo was strongly emphasized.
4. To afford protection to centers of population and generally to the people living behind the main river levees, water must be permitted to escape at designated localities from the leveed channels in sufficient quantity to remove the general hazard of levee failure.

To reduce the flood plane at Cairo, Ill., and opposite the St. Francis Basin in Missouri, a considerable setback

MOVING AN OLD LEVEE BACK A HALF MILE

in the main river levee was projected between Birds Point and New Madrid, Mo. This was such as to avoid higher levees at Cairo.

Along the Mississippi, below the mouth of the Arkansas, it is impossible to raise the levees sufficiently to restrain the combined flood flow of the two rivers. Fortunately, the head of the so-called Boeuf Basin is just below the mouth of the Arkansas and the basin itself extends to the Red River backwater which, in turn, leads to the head of the Atchafalaya Basin, and so affords a natural means of escape for the flood waters of the Arkansas and the Mississippi to the Gulf of Mexico, near the mouth of the Atchafalaya, without their return to the main channel. It is calculated that 900,000 sec-ft. or more must escape this way if the adopted levee grade between the mouths of the Arkansas and Red rivers is not to be overtopped.

The normal banks of the Atchafalaya River are leveed from its head down to the swamp as far as is practicable at the present time. But the discharge capacity between these levees does not exceed 500,000 sec-ft.

Between the mouth of the Red River and the city of New Orleans, the levees along the main stream are designed to carry a maximum of 1,500,000 sec-ft. It is seen, therefore, that an equal amount must be permitted to escape down the Atchafalaya Basin in order that the main river levees between the mouth of the Red River and New Orleans may remain intact.

BONNET CARRE SPILLWAY COMPLETED

It is scarcely practicable to raise the levees on the New Orleans waterfront without a very large expense in the alteration of the port works. A discharge of 1,250,000 sec-ft. past New Orleans is regarded as safe, since it can be accomplished with a Carrollton gage reading of not more than 20 ft. But the discharge between levees on the main stream, below the mouth of the Red River, may be as high as 1,500,000 sec-ft., so that it appears necessary to remove as much as 250,000 sec-ft. from the main channel above New Orleans. This is provided for 17 miles above the city by a floodway at Bonnet Carre, located where the river bank is at present stable and

likely to remain so, and where drift is not expected to be embarrassing. This floodway discharges into Lake Pontchartrain, from which excess waters find their way to the Gulf by way of Lake Borgne.

The throat of the floodway is simply an opening in the main river levees, with side levees from 8,000 to 12,000 ft. apart erected to confine the water in the floodway. Across the floodway, and a short distance from the river, is a sill of concrete and a needle dam. The sill, which is founded on piles, has a concrete apron downstream. At its toe, this apron is protected from scour by a flexible concrete mattress which, in turn, is protected along its lower edge by riprap. The needles of the dam are timbers 12 in. wide, resting on the sill at their lower ends, and on an escape bar at their tops. They remain in place until the water in the river rises to the danger point, at which time it is planned to remove them and put the floodway into operation.

View South on Discharge Side, Baffles and Articulated Slab

View North, Hand Crane for Placing Needles

BONNET CARRE SPILLWAY COMPLETED

WIDTH OF FLOODWAYS A PROBLEM

Much fault has been found with the width of the proposed floodways, which have been designed in section to accommodate the desired discharge without clearing the forests and brush that now exist. They can be made narrower if cleared, and narrower still if higher confining levees are used. Either method would greatly increase their cost. Their over-all length is 250 miles or more.

The clearing of brush from the narrow floodways would be an annual expense which, when capitalized, would reach many million dollars. To clear by hand a floodway 4 miles wide and 250 miles long, would cost $3,000,000 annually in addition to the first cost of clearing. This sum capitalized would add $50,000,000 to the first cost. Perhaps some cheaper method of keeping floodways cleared may be found, or the use of the land may be made to pay for the clearing, but no such method has yet been evolved.

In place of the "fuse-plug" levees, movable dams, such as that used at Bonnet Carre, have been suggested. However, the cost of each such dam would be about $17,000,000, and unless owners of land in the floodway were dispossessed, they would not permit the dam to be opened. The alternative would be outright purchase, at a probable cost of $200,000,000 if the wide floodways were used.

A fixed weir would be preferable. Both it and the movable weir would cut off the flow into the floodway as soon as the water fell below the danger point. If the question of payment for land could be eliminated, fixed weirs might be built in place of the existing fuse-plug levees. But there is a probability that weirs would be tampered with in flood time to prevent their use.

The building of reservoirs on the watershed of the Mississippi was suggested by Ellet in 1850. He pointed out they they would obviate floods and promote navigation. The idea was rejected by Humphreys and Abbot on two grounds: first, the expense of the system; and second, the impracticability, if not impossibility, of securing enough reservoir capacity to contain the flood waters. The conclusion of Humphreys and Abbot was quite sound.

PURPOSES OF RESERVOIRS

In considering reservoirs for several purposes it should be remembered that these purposes may be conflicting. If reservoirs are to provide for power or irrigation they should be kept full as long as possible; no water should be allowed to escape which might be needed in an unpredictable future. In the case of power, water must sometimes be stored in summer for use in winter, and at other times the reverse is necessary. For purposes of navigation, reservoirs must remain full until periods of low water. It is not possible to predict with certainty when low water is coming; that depends on the rains of the future as well as on those of the past.

In the case of flood protection, reservoirs must be kept empty as long as possible, and emptied as quickly as possible when they are full. If a reservoir is to be used for several purposes, certain parts of it must be reserved for each purpose exclusively. Such a plan will require a great deal of reservoir space if flood control is one of the objects to be accomplished.

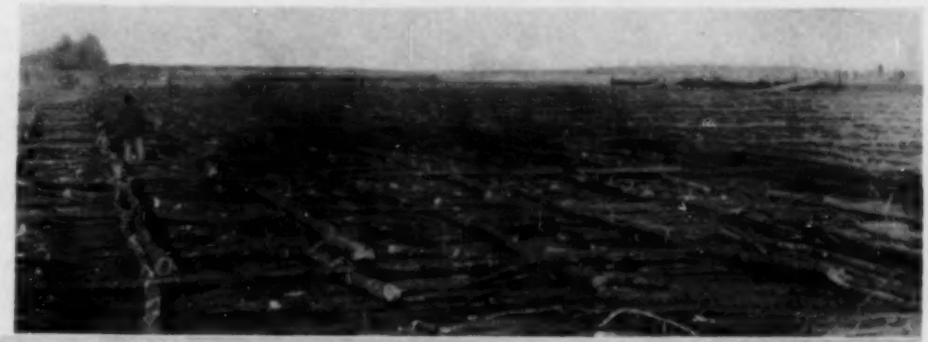
POSSIBLE RESERVOIR SITES EXAMINED

Possible reservoir sites on the Arkansas, the White, and the Red rivers have recently been examined with a view to flood relief in the Mississippi Valley. Results have been disappointing and discouraging. These rivers are so situated, on the flank of the lower valley, that reservoirs built on them would have the maximum effect on the floods in that valley. But the results which could be obtained, when considered in connection with the cost, positively preclude such construction.

Many engineers believe that the fear of cut-offs to straighten the river has not been founded on experience. However, observation of the cut-offs made by nature in the past seem to justify such fears. Previous cut-offs introduced a state of change that was far reaching and for some time harmful to navigation interests and of others. The cost of work to prevent the Leland's Neck cut-off was $500,000. Under the circumstances, such a cut-off might have caused damage ten times that amount before preventive measures could have been taken. Although the bends above Greenville have shown no marked change since 1882 except a slight general movement downstream, they are considered a menace in their present condition. Levees in their vicinity will be made secure in height and position and then, if cut-offs do occur, it is to be hoped that nothing more serious than disturbed navigation conditions will be the result.

TYPES OF BANK PROTECTION NOW IN USE

Sinking an 8-Acre Willow Mat with Riprap



An Articulated Concrete Mat, Extending 325 Ft. out from Shore

Completed Section of Paving and Slab Work

dangerous to levees. Above and below, the current was accelerated; there was more caving of banks in the vicinity; new bars were formed; and other changes progressed at an increased rate.

CUT-OFFS PREVENTED

It was shown by Humphreys and Abbot that the water surface was lowered above a cut-off and raised below it, and they concluded that a series of cut-offs would produce no other effect than to lower the surface from the middle of the reach upstream, and to raise it correspondingly below. For these reasons the making of cut-offs has been vigorously resisted, and they have not been made.

Last year a cut-off was threatened at Leland's Neck, just above Greenville, Miss. In the vicinity immediately above this town there are other narrow necks, and the cutting through of one might induce the cutting through

RESULTS TO BE EXPECTED FROM CUT-OFFS

Perhaps, if a reasonable rectification of the bends were planned and carried out successively from below, with ample protective measures taken in advance, results would warrant the effort. The known results would be: (1) removal of the menace of cut-offs occurring without full preparation for them; and (2) a shortening of the navigation distance between the mouths of the Arkansas and Red rivers by one hundred miles. Probable results would be: (1) no serious change in the depth, since the slope would not be increased beyond that which obtains in sections carrying less water; and (2) an appreciable increase in the discharge capacity of the flood channel in the reach in question, where such increased capacity is much to be desired.

It is evident that very careful bank protection in advance would be necessary. Before cut-offs are recommended, a thorough study should be made of the results to be expected. If such a project were undertaken, it would be possible, by beginning work at the lower end of the reach and proceeding carefully upstream, to note the effects before carrying out the plan in its entirety. Careful experiment in the laboratory would indicate the

effect on flood discharge, and the location and extent of the bank protection needed.

There have been no radical changes in the character of the works used for flood control along the Mississippi. Levees have been raised moderately, and their sections have been enlarged by a slight increase in width on top,

BANK PROTECTION METHODS
Cutting to Proper Slope by Hydraulic Sluicing

and by a flattening of the slope, especially on the land side, so as to include more certainly the line of saturation. Banquettes have been removed from the land side and the slope made continuous from crown to toe. No attempt has been made to select special materials for the building of levees; they are constructed of the same soil as that on which they rest. Different sections are used for different soils, the effort being to get absolute security in the levee.

For moving earth in levee building, the most approved methods are used. A dragline operated from a crane or a tower is the standard method, but tractors and trailers are employed for long hauls.

Willow mats are still used for bank protection, although willow is not available in the quantities desired and the tendency of optioning large areas of it by contractors is not calculated to make for free competition in bidding. For this reason woven lumber mats may come into use. Another disadvantage of the willow mat is that it deteriorates rapidly when exposed above low water, while concrete mats can be laid equally well at high or low stages.

Two forms of concrete mat are in use; one made of small slabs articulated on cables, and the other of large slabs laid so as to overlap. Of these, the small-slab type appears preferable from the standpoint of effectiveness and cost.

Formerly the upper part of the banks was covered with riprap, but of late the practice has been to cover it with a sheet of concrete, as illustrated. This seems to me a wrong step, the results of which should be watched with care.

The importance of grading the banks to a uniform flat slope extending the entire width of the mat has been fully recognized, with the result that the mechanical grader is preferred to the hydraulic jet. At the present time much bad protective work on upper banks can be seen along the Mississippi, owing to emergency efforts which required the laying of mats on unprepared banks.

LEVEES VERSUS BANK PROTECTION

It costs about $175,000 a mile to build the new levees on the increased section, but it costs $350,000 a mile to protect the banks, so, ordinarily, if a levee is threatened, it is moved back. This greatly irritates and inconveniences the people, for they are then obliged to move their roads as well as their houses, schools, and churches. If a development is sufficiently valuable, however, the bank is protected and the levee is not moved.

Altogether, there is room for much progress in the work of bank protection, and there is a tremendous demand for more such work. Yet it is an extremely expensive undertaking, discouraging to carry out. The effective solution of this problem will be proof of the ability and resourcefulness of those who have the work in charge. Bank revetment should show much improvement in effectiveness and durability, and a reduction in cost. Navigation and flood control are both seriously affected by, if not dependent on, bank stabilization.

PROTECTED BANK, CONCRETE REVETMENT IN PLACE

Generally speaking, work on the flood control program is being carried on with much vigor and efficiency. In spite of clamor, criticism, and opposition, the rate of progress is greater than that prescribed by Congress, and the cost is within the estimate.

Sand Movement and Beach Erosion

Economic and Esthetic Solutions for Problems of Shore Protection

By E. J. Dent

Member American Society of Civil Engineers
Lieutenant-Colonel, Corps of Engineers, U.S.A., Fort Humphreys, Va.

INCREASING usage of existing beaches and the increasing value of shore property justify expenditures for more substantial and more attractive protection works. Methods of maintaining the stability of beaches must be considered not only from an economic, but also from an esthetic point of view. The cost of jetties and sea walls designed to reduce wastage of beach materials may exceed that of replacing the loss by artificial means, and the second method may create a more sightly and useful beach. Where expenditures for replacing the waste are in excess of those for building protective structures, the beauty and utility of the beach to be maintained must also be evaluated. In this article, abstracted from the paper read before the Norfolk Meeting of the Society, in April, Colonel Dent presents a study of wave action, its effects on certain types of beaches, and the selection of a suitable method of beach protection or maintenance.

REGARDLESS of the scenery which the land itself offers, the natural attractiveness of the ocean front draws millions of people each year to the seashore along the Atlantic and Pacific coasts. At Coney Island it was estimated in 1923 that the development would take care of 250,000 bathers at one time, an average of 28 per lin. ft. of beach. In addition to this, the boardwalk was calculated to carry 8 persons per lin. ft. Beaches along the south shore of Long Island and along the New Jersey shore are very much congested, although the figures estimated for Coney Island are not duplicated.

Improved highways not only add to the size of the crowds brought from the great centers of population by railroad and trolley lines, but in addition they make other beaches available for those who travel by automobile. There are many localities where the use of the shore is already intensive and where the development is assuming a permanent and costly form.

With so great an increase in patronage, there are at present many municipalities that can no longer plead poverty as an excuse for failure to improve and develop their principal asset, the waterfront. The value of shore property of the resort communities of New Jersey increased from approximately $57,000,000 in 1899 to approximately $600,000,000 in 1929.

Along the northern parts of our shore line, where summer colonies are built, the problem of maintaining bathing beaches is not as important as it is farther south. In the north, sea walls preventing the actual undermining of buildings often present a reasonably satisfactory solution, but where summers are warmer a sandy beach for bathers is essential.

Boardwalk and Beach at Coney Island
An Extensive Improvement Project by the City of New York

Beaches within a mile or so of the entrance channels of our great commercial harbors are at times affected by the improvement of these channels. Numerous minor inlets are being improved to allow transportation of heavy freight to a sizable shore community. This work also has an effect on the adjoining beaches for a short distance on each side.

HUGE OUTLAY FOR SHORE PROTECTION

In studying this problem of beach erosion, I have inspected some of the largest structures which have been built in this country for shore protection, the bleachers at Revere Beach, Mass., and in Harrison County, Miss.; and the sea walls at Virginia Beach, Palm Beach, Galveston, Tex., and San Francisco. It is evident that the total sum expended on these heavy structures and on the great number of groins and bulkheads erected in connection with them, would reach a formidable total if detailed data were available. The extensive losses by beach erosion that have been recorded in recent years, and the grim defensive struggle that is now going on in many places, testify to the seriousness of the situation.

In 1929, the growing importance of the problem resulted in the appointment by the War Department of a board to study "sand movement and beach erosion." In 1930, Congress passed specific legislation calling for the appointment of a board, to consist of three civilians and four engineer officers, to make a similar study in cooperation with local governmental agencies. At the same time still another board was appointed by the Chief of Engineers, to report on subjects falling within the scope of the river and harbor work under his jurisdiction,

and not involving cooperation with state agencies. I was appointed a member of the 1929 board and also of the two boards selected in 1930, which have taken over the work of the original board. This paper, in many respects, is a preliminary statement, representing my present views and not necessarily those of the boards.

UNSIGHTLY CONDITIONS ALONG HIGHLY DEVELOPED FRONTAGE
Shore Protection of This Nature Does Not Provide a Bathing Beach

A PUBLIC BEACH IN EXCELLENT CONDITION

A PRIVATE BEACH CLUB WELL MAINTAINED

As new facts are developed it may be necessary to alter views that are now held.

Most of the attention of the boards will presumably be given to the development and maintenance of sandy beaches along the barrier islands which skirt most of the Atlantic coast. The material encountered in such localities is unconsolidated sand, and the rate at which it is being eroded has become a matter of great concern.

An abundance of geological evidence shows that the seas are forever eroding the land and creating marine shelves along their borders. The rate at which this erosion progresses depends on many conditions, among which are the character of the materials encountered and the exposure of the site. Accummulating evidence indicates that this encroachment of the seas on the continents is in reality a very slow process, requiring centuries or millenniums to effect any great changes. Such rapid changes as may be noted at many localities are ordinarily due to the movement of beach material from one point to another, and when the accretions as well as the erosions are accounted for, the net changes in continental area are not very great.

Unconsolidated sandy deposits make up the entire shore line of New Jersey, which is approximately 125 miles in length. Judging from the character of the materials, erosion along this coast should be quite rapid. It may be observed also that this shore line is exposed to the storms of the Middle Atlantic, which are intermediate in intensity between those of the Gulf coast and the North Pacific. The Board of Commerce and Navigation of the State of New Jersey has estimated that the net loss in acreage to that state since 1837 has amounted to about 2,000 acres, which reduces the average rate of encroachment of the sea to about 18 in. per year.

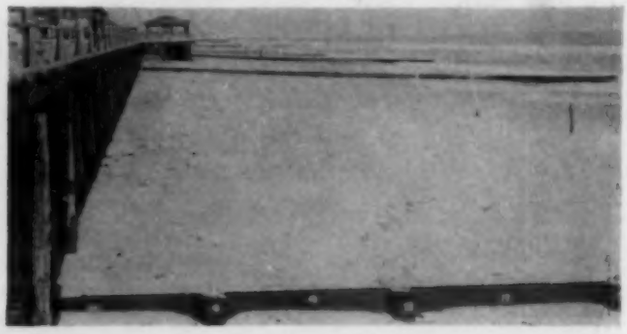
If the immediate concern of the beach protection engineer ends with a depth of about 40 ft. below mean low water, the loss of 18 in. of beach per year can be made good by the annual deposit of about 3 cu. yd. per lin. ft. of beach by artificial means. For beaches which are used extensively, the cost of this replacement is a relatively small item.

ALONG-SHORE DRIFT OBJECTIONABLE

Assuming that the annual loss due to the net encroachment of the oceans on the continents amounts to so small a figure that it can be readily replaced by the deposit of fresh material by artificial methods, the problem of shore protection is greatly simplified. Although this figure is small and there is the possibility that the material washed away is being deposited at some other point, it is unthinkable that the erosion of highly developed property such as may be seen at Asbury Park, Long Beach, Atlantic City, Long Branch, and elsewhere, should be allowed to continue. Moreover, the deposit of sand in any locality may not be of advantage to that frontage. An accretion of several hundred feet in front of some great hotel or pavilion might seriously impair its value as a beach-front development.

Control of the along-shore drift of sand in such a manner as to prevent the erosion of highly developed property, and at the same time to stabilize the beach front of other property by the prevention of extensive deposits, is probably the main problem to be faced by shore-protection engineers in the future. Pioneering work along this line has been done, and the financial

feasibility of adequate shore protection for many of our beach colonies should be regarded as definitely proved.



EXAMPLES OF UNSIGHTLY BEACHES
An Effective but Costly High Rock Jetty, and Wooden Groins Incapable of Maintaining a Satisfactory Beach

Further work will involve the use of structures whose adequacy has been fully demonstrated.

SUCCESSFUL SHORE PROTECTION PROJECTS

In 1923, the City of New York completed an extensive improvement project at Coney Island, involving about 9,000 lin. ft. of beach. Sand was pumped ashore to extend the low-water line several hundred feet seaward. To prevent the newly deposited beach material from being carried along shore by the littoral drift, 16 jetties were built. The results of this work have been most satisfactory. The loss of sand since 1923 has been roughly estimated at 3 cu. yd. per lin. ft. per year.

At Asbury Park and Long Branch, N.J., a number of rock jetties have been constructed, and there has since been a material natural accretion to the beach.

It may not be amiss to compare the situation along our beaches with the condition of our highways a few years ago. Twenty years ago, a highway that was passable in all weather was considered reasonably adequate. Today, it must not merely be passable, it must also be wide, smooth, and well landscaped. A somewhat similar situation exists today in our bathing beaches.

An investigation of such projects as those at Coney Island, Asbury Park, and Long Branch shows that it is feasible to guarantee security along the short front, and our developers should now proceed with assurance in the construction of sightly and luxurious works to add to the enjoyment of excursionists. In providing for beach protection in the future, the estimate of benefits should include esthetic as well as purely utilitarian values.

In places where a beach has been eroded until the waves cut into the dunes, the profile is normally concave upward, as indicated in Fig. 1. In such cases there will ordinarily be found a nearly vertical cliff which is being undermined, the talus due to any cave being soon carried away by the combination of wave action and currents. Along a shore line of this nature, the force of the ocean is working on materials that have been in place for many years or centuries, and have acquired a certain amount of cohesion and resistance to erosion.

Where a beach has been recently widened by accretion, the profile normally shows one or more berms, as indicated in Fig. 2. From the mean low water line to the crest of Berm B, the slope depends mainly on the coarseness of the materials. In the fine sand at Cape May, the slope is ordinarily from 1:25 to 1:50, and in the coarse sand at Manasquan, it is usually about 1:10. In gravel it is often as steep as 1:4. Where the sand is fine and the slope flat, a hard beach will usually be found. Examples of those smooth, flat beaches where automobiles may be run at record-making speeds are found at Cape May, N.J.; Wrightsville Beach, N.C.; and in beaches around Charleston, Fernandina, Jacksonville, and Daytona. The beaches of northern New Jersey and southern Florida are ordinarily steeper, the sand being coarse and loose. In New England, gravel beaches may be found in many localities.

In Fig. 2, the elevation of Berm B depends upon the height to which the uprush of the waves extended at the time the berm was built. The elevation of Berm A shows that it was built up during higher tides or more severe storms than those which resulted in the formation of Berm B. The cliff at the dune line indicates that, at a comparatively recent date, the ocean has eroded back as far as this point. The loose sand comprising the berms

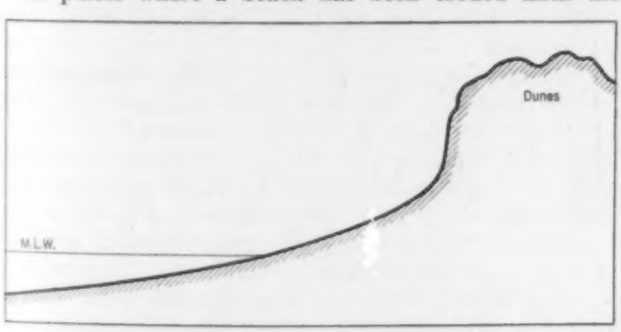


Fig. 1. Beach Subject to Erosion

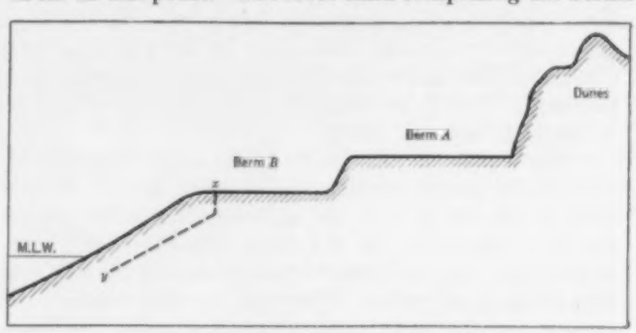


Fig. 2. Beach Undergoing Accretion

BEACH FORMS CAUSED BY WAVE ACTION ON CLIFFS, SEA WALLS, OR BULKHEADS

is readily shifted by wind action, and whenever a smooth unmodified berm is in evidence, it is proof that the sand has been recently worked over by wave action.

The division between Berms B and A may be a nearly vertical cliff, showing that erosion had reached that point

APPEARANCE OF AN EXCELLENT BEACH INJURED BY HIGH GROINS

just before the formation of Berm B. If the outer crest of Berm B is rounded, it is presumptive evidence that accretion is still in progress. If erosion is under way, the profile normally takes the form of the broken line X Y. In fine sand there may be an intermediate stage of beach form, brought about by insufficient accretion to create a well defined berm. Exact stability is rarely present, as either accretion or erosion is ordinarily in progress.

WAVES AND CURRENTS

During prolonged and heavy gales, waves approach a pointed form and the tops are often blown forward, creating what are known as white caps. When the wind ceases, long undulatory waves, known as ground swells or rollers, may continue for hours or days. The form of the ground swell conforms closely to that of a prolate cycloid, and on this form a mathematical theory for wave motion has been evolved. This theory is often referred to as the trochoidal theory.

Observed phenomena of deep sea waves bear out the trochoidal theory, and its essential accuracy may be accepted. In coast erosion studies, however, it becomes necessary to deal with waves in shallow water, which depart widely from that theory.

A deep-sea roller of moderate height contains a great amount of energy, which is mostly dissipated by interior friction due to a series of breaks before the wave actually rolls up on the beach. At the time of its final break, the work done by the wave is partially constructive and not wholly destructive. Breakers several feet in height, a thousand feet or so off shore may be reduced to a small fraction of this size before making the final plunge upon the sand. This is particularly so in the case of beaches of fine sand and flat slope.

When a roller breaks in 20 ft. or more of water, the overfalling water impinges on a deep cushion affected only by orbital motion, and therefore has little effect on the bottom. Close to the shore, the overfalling mass strikes bare sand or a layer of water so thin that all orbital motion is destroyed. This final break is known as the plunge, and the point where it occurs is called the plunge point. The crest of a wave toppling over a height varying from a few inches to three or four feet, at the plunge point, causes large quantities of sand to be thrown into suspension. Samples taken at Long Branch show that the average weight of suspended sand at the plunge point was nearly 6 per cent of the total weight of the sample.

Following the plunge, a boiling, foaming mass of water flows up the beach until its energy is exhausted against friction and gravity, after which, still under the influence of gravity, the water flows back down the slope. These phenomena are appropriately called the uprush and backwash. In Fig. 5 is shown the result of a few determinations of the percentage of sand in suspension at and near the plunge point.

The speed with which a deep sea roller, or the subsequent shallow water wave, advances toward the shore should not be confused with the velocity of the individual

DEFENSE OF A SHORE LINE BY BULKHEAD AND GROINS

particles of water. A swell 4 ft. in height, from trough to crest, might be advancing through deep water at a rate of 40 ft. per sec. with a wave interval of about 8 sec.; but the orbital velocity of a surface particle of water under such conditions would be only about 1.6 ft. per sec. This velocity of the particle decreases rapidly below the surface.

WAVE ACTION IN SHALLOW WATER

It is often stated that the orbital motion of individual particles of water is lost when waves reach shallow water, and that the deep sea roller becomes a wave of translation. In this, it is inferred that the velocity of the particles is fairly commensurate with the speed of the wave. However, in such specialized cases as may cause waves of translation to be created, the water moving toward the shore must find a nearby avenue of escape. An offshore bar, nearly awash, may create such waves of translation, but even in this case the velocity of the individual particles is small when compared to the velocity with which the waves approach the bar from deep water.

Observation of wave action in shallow water has been made to obtain actual data as to the movement of individual water particles. The path of a surface float, plotted by means of a motion picture camera, is shown in Fig. 3. It will be noted that there is no great regularity of motion nor a great preponderance of travel in any direction. During this observation, the float moved a few feet toward the shore as a result of the passage of several waves. The on-shore flow of water at this point must necessarily have been compensated for by an offshore motion somewhere else. The figure indicates that the trochoidal theory of wave motion is of doubtful

applicability to conditions in the shore zone, where the beach erosion engineer is forced to match his wits against the onslaught of the waves.

SAND MOVEMENT AND EFFECT OF JETTIES

In the vicinity of rocky headlands, beach material may consist of fragments of various sizes, the larger ones rounded by the grinding action, and the finer ones transported to and segregated in protected coves. Along the Atlantic coast, from Long Island to the Carolinas, the sand encountered is mainly silica in the form of angular grains. These grains, which were originally embedded in the crystalline rocks, were loosened by the weathering of minerals surrounding them. The combination of rains, stream flow, and ocean waves and currents has caused their aggregation and deposit in the

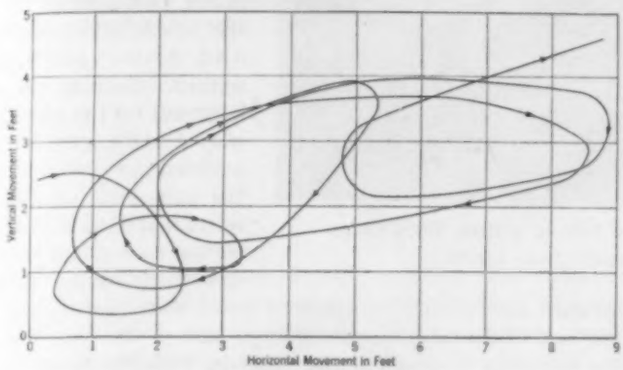


FIG. 3. PATH OF A SURFACE FLOAT
As Observed by a Motion Picture Camera

localities where they are now found. Along the New Jersey shore it will ordinarily take from one million to one hundred million grains of sand to weigh a pound. Reduction in size due to abrasion resulting from impact of particles is a very slow process. In the Carolinas, shell fragments constitute a material percentage of the total beach material, and in parts of Florida the calcium carbonate content may exceed 50 per cent.

RATE OF SAND SETTLEMENT

All beach sand appears to settle quite rapidly through still water. At Long Branch the typical rate is about 2 in. per sec., and at Cape May it is approximately 0.5 in. per sec. Moderate currents alone are not very effective in moving such sand. A good example may be found in the Mississippi River, at and below New Orleans, where the currents exceed 5 ft. per sec. for weeks at a time, and where the load of sand which will settle at 0.5 in. per sec. or faster is exceedingly small.

Along the coast line, as the waves pass over a given point, the oscillatory movement of the bottom layers of water often moves the sand back and forth. This may be observed by a diver. If at the same time there is a current, it will give this disturbed sand a progressive motion in the direction of the current. Along-shore drifting due to the combination of waves and currents is found in water of depths as great as 50 ft.

In shallow water, the disturbance of the sand, due to wave action, results in the lifting of small quantities well above the bottom. The littoral currents carry this material considerable distances before it can again settle to the ocean bed. Observations made at Long Branch, N.J., in water about 15 ft. deep, are shown in Fig. 4. It will be noted that the load of suspended sand increases rapidly toward the bottom, but that it is never of great magnitude. From Fig. 5 it can be seen that an along-

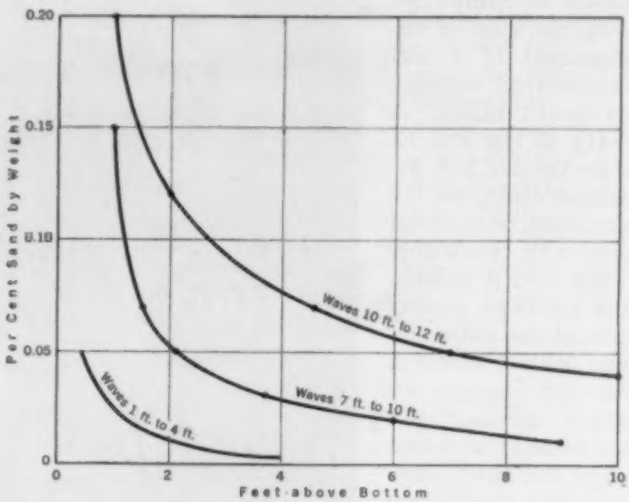


FIG. 4. SAND PLACED IN SUSPENSION BY WAVE ACTION
Weight of Sand Related to Total Weight of Samples

shore current in the zone just seaward of the plunge point will result in the movement of large quantities of suspended sand. The uprush and backwash also move large quantities of sand to leeward along a zigzag path.

A combination of causes produces the total along-shore movement of sand. The forces concerned may be called the "beach drifting forces," and may be described as moving the sand from windward to leeward. If at any point the beach drifting forces are not fully loaded, there is a tendency to pick up more sand, thus causing local erosion. If for any reason the load is greater than the capacity of the forces, accretion will result.

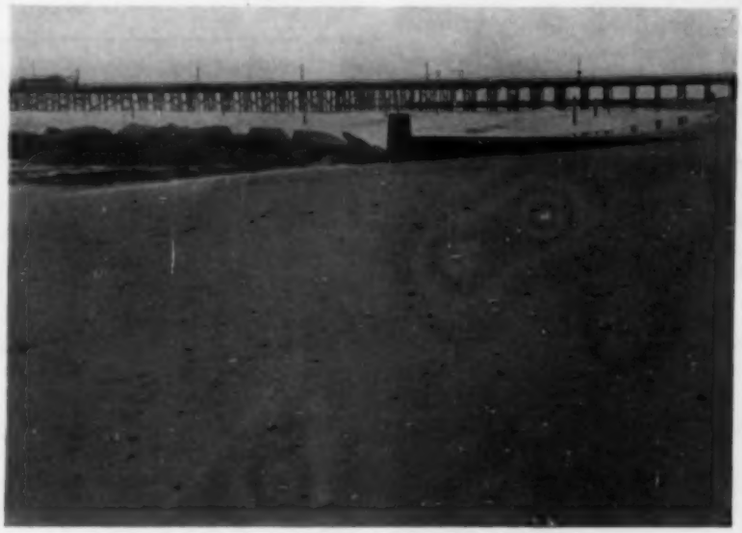
In building jetties to retard erosion or to cause accretion, the capacity of the beach drifting forces and the load arriving from the windward must both be considered. If the load arriving from the windward beaches closely approximates the full capacity of the forces, then a structure that only slightly reduces their capacity may cause a marked accretion. At the opposite extreme, cases will be found where the amount of sand brought in from the windward is so small that the jetty must, to be successful, reduce the beach drifting forces to practically zero.

ECONOMIC STUDY REQUIRED

Under modern conditions, no community is entitled to a continuous supply of fresh sand from the windward unless the community itself owns the source of supply. Assuming that a community supplies, at its own expense, the sand necessary for the maintenance of its waterfront, an economic study is required to determine the proper balance between expenditures for the replacement of wastage and those for its prevention. The beauty and utility of the beach to be obtained and maintained should also be evaluated.

From Fig. 5 it may be seen that a high jetty, extending from the shore to a point 60 ft. seaward of the plunge

point at low water, will cut off and and impound most of the drifting sand. If the sand passing around the end requires periodical replacement, an estimate should be made of the cost of a reduction in loss by extending the structure. This cost should be compared with the cost of replacement of a corresponding wastage by direct means. A jetty of less height than the one just described could, for the same cost, be extended further seaward. This would reduce the wastage passing around the outer end but would allow a certain amount to occur through the movement of sand over the shore end. Assuming these two jetties to be of equal value in preventing beach drifting, and so proportioned that any further extension would not be economical, the effect on the appearance and utility of the beaches should be the deciding factor.



BEACH FORMED ON THE WINDWARD SIDE OF A HIGH ROCK JETTY
Boardwalk in Background, Coney Island

As the sand accumulates on the windward side of a high jetty, the shore line advances until eventually the sand passes around the outer end. A series of such structures would result in a saw-tooth beach alignment, the offsets being marked by the jetty structures projecting above the sand. The lower jetty would allow most of the drifting sand to be carried over the shore end and used directly for the maintenance of the leeward beach. Considering the development of the entire frontage, a series of such low jetties would result in a more nearly continuous and a more sightly beach than a series of high jetties.

With low jetties, a large percentage of the sand artificially or naturally supplied at the windward boundary of the improvement would travel along the entire length of a continuous beach. If 6 jetties per mile are required, and if the improvement is one mile in length, the cost of replacing lost sand must be balanced against the cost of increasing the dimensions of 6 jetties. If the improvement is 3 miles in length, the cost of enlarging 18 jetties must be considered. If the leeward boundary of the improvement is adjacent to an improved inlet, a high jetty designed to force the passing sand into relatively deep water may be the proper solution.

Consideration should be given to the direction of a jetty axis with respect to the shore line. If the purpose is to stabilize a beach by reducing the volume of littoral drift, there appears to be no reason for departing materially from a line perpendicular to the shore. Waves ordinarily swing so that their direction of travel, just before the plunge, is nearly perpendicular to the shore line. A departure of more than 15 deg. from the perpendicular would be unusual.

In substantially all localities, the drifting sand of the beach will have a well defined resultant motion over a period of years, the sand moving from windward to leeward. A jetty perpendicular to the beach concentrates the force of a diagonally approaching wave and causes erosion in the angle at the junction between the jetty and the beach.

On the windward side, beach sand approaches the jetty in a fairly continuous stream and the erosive forces encountered near the structure itself may cause a minor embayment of the beach, which will not, however, be serious. Such an embayment on the windward side can be avoided by inclining the axis until, on the windward side, no waves race along the structure, but on the leeward side of such an inclined jetty, waves race along the face of the structure for a large part of the time and the tendency to erode at the junction with the beach is seriously aggravated. On the leeward side, the beach drifting forces transport the sand away from the jetty. Such a design will, therefore, have a strong tendency to erode on the leeward side and fill on the windward side, the net result being a saw-tooth alignment in its most aggravated form.

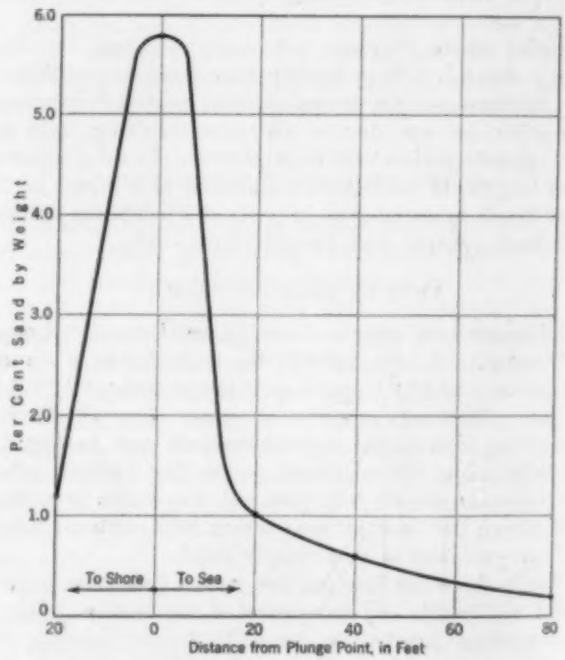


FIG. 5. PER CENT OF SAND IN SUSPENSION
At and Near the Plunge Point

Developing Aerial Transport

Progress in Commercial and in Army and Navy Aviation Outlined

FROM ancient times it has been man's ambition to fly. Greek mythology records the unsuccessful flight of Icarus, who fell into the sea when the sun melted the wax that fastened his wings. In the fifteenth century, Leonardo da Vinci observed that if man would fly he should imitate the webbed wings of the bat rather than the feathered wings of the bird.

The three following articles on various phases of aerial transport have been prepared from papers presented on April 15, at the Norfolk Meeting of the Society. In outlining the development of commercial transportation, Mr. Conroy shows how what was once an expensive toy is now becoming a useful part of the equipment for the development of rapid commercial transportation. The development of the use of aircraft during and since the Great War for observation, demolition, attack, and pursuit, is traced by Captain Kenney of the Army. In his paper, Captain Whiting of the Navy, gives particular attention to the devices and equipment which have been perfected for the launching of planes from ships at sea and for landing them again on deck.

Commercial Transportation

By V. P. CONROY
DISTRICT TRAFFIC MANAGER
NATIONAL AIR TRANSPORT, INC., NEW YORK

DURING the past decade, aviation has come to occupy an important position in the field of commercial transportation. Many problems have naturally arisen in connection with the development of such aerial service. At present, however, the chief factors involved are the cost of operating facilities and of necessary experimentation, and the building-up of a paying traffic in mail, express, and passengers.

The first experiments in air transportation were made on the short mail route between New York and Washington, D.C., as recently as 1918. At the present time, the Air Commerce Bulletin of the U.S. Department of Commerce lists some 96 services in the United States and approximately 18 in foreign countries, operated by American companies, making a total of about 115,000 miles of flying each day over approximately 40,000 miles of airways.

I shall take one United States airway and call attention to the details of preparation and maintenance which have been found essential for its efficient operation. This will give an idea of the tremendous amount of organization necessary to carry on aerial service in the domestic and in the foreign field, that is, in South America, Mexico, and the West Indies.

The airway between Newark and Cleveland has approximately 15 intermediate fields. Because of the rugged terrain, it has been necessary to build practically all of these into the side, or on the top, of the mountains. Great sections of forest land have, in many cases, been cleared away in order to facilitate the landing and taking-off of mail planes. Between these intermediate fields are located emergency fields, both directly on the airway and to each side of it, so as to permit the operator to bring his plane down safely regardless of conditions. A weather observer, in the Government employ, is stationed at each of these intermediate fields.

In fact, the service that the weather-reporting system gives to operators is probably one of the most vital factors in air transportation. The Government's weather observer, at various periods throughout the day—once an hour is the minimum for local conditions—reports to key stations, where meteorologists of experience are located. These men compile the information by means of a teletype system and draw up weather maps from the data collected from the intermediate fields as well as from zones away from that particular airway.

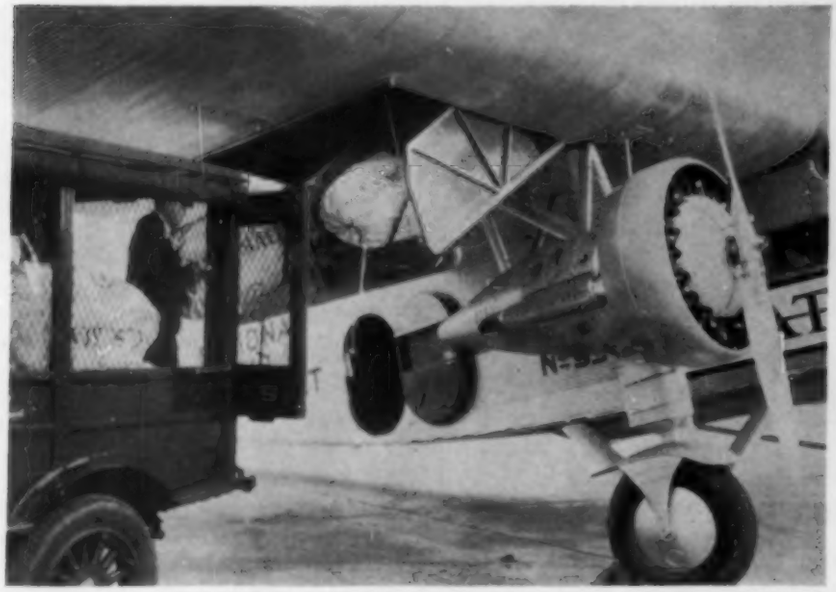
In the case of the Newark-Cleveland airway, reports from the local stations are sent once every hour. Points away from the airway report from one to six times each day, depending on the influence the weather at that point has on the airway in question. Even from the farthermost points in the United States, local weather observers send in data to the meteorologists at the control fields so that these men have a perfect picture, not only of local conditions, but also, as a result of charting their weather maps, of the drift of storms across the entire country.

Accurate knowledge of weather conditions is particularly important along the airway in question, because it is generally affected by the four storm paths which traverse the United States. Storms coming down from Canada—that is, from Alaska and the western part of Canada—or those coming directly across from the West, up from Texas and Mexico, or from the West Indies, all have a tendency to center their paths over this region as they leave the continent through the St. Lawrence Valley. It is because of this condition that the Government has concentrated most of its pioneering efforts on the Newark-Cleveland airway.

After this weather reporting system was instituted, it was found inadequate for the field manager to acquaint the pilot with conditions previous to his taking off. Weather conditions often change so rapidly that the pilot must be informed of them while he is actually in motion, and it was because of the necessity for this that experimental work on the radio was undertaken. Inci-

dentally, it is a strange fact that the first practical result of radio experimentation work was not telephonic communication but rather the development of the radio beacon system.

This system is simply a two-loop antenna arrangement on stations located approximately two hundred miles apart. Between Newark and Cleveland there are three broadcasting stations—one at Newark, one at Bellefonte, Pa., and one at Cleveland. These two-loop stations broadcast down the airway two characteristic signals. Going west from Newark, the antenna to the left broadcasts the letter *A*, which goes down the left side of the airway. The other loop broadcasts the letter *N*, down the right side of the airway. The two signals, dot dash to the left and dash dot to the right, combine to make a signal directly down the center of the airway. This signal is a constant dash, or the letter "T" in the Morse code, so if a pilot should become blinded by fog while flying he would know he was directly on his course as long as he kept his plane pointed down the letter *T*.



WING BOX FOR MAIL OR EXPRESS CARGO

In order to eliminate the possibility of overshooting the mark, localizer beacons have been stationed at various important intermediate fields along the way. These beacons are simply short-wave transmitters having a range of approximately five miles; and each one of the fields has a characteristic signal, much the same as the flashing lights used in piloting coastwise navigation. A pilot flying to Bellefonte in a fog, or through a cloud formation which did not permit him to fly low enough to identify his location, would follow this radio beacon course, and to check his progress along the airway, would be on the alert to pick up localizer signals en route.

This signal system has been found to work out in practice and, in order to illustrate how valuable it can be under certain conditions, reference will be made to two flights, one with and one without the beacon.

A few months ago, a pilot took off from Cleveland in a radio-equipped ship and flew the 420 miles to Newark practically blind all the way. When he arrived at Newark, he was under the impression that the ceiling had closed in to the ground for he was unable to break through the fog as he swung over the field, which he had located through the intensity of the beacon signal. However, the men at the field heard his plane go over and told him over the radio beacon transmitter, that he had gone over the field on the right course and that, if he would double back and break down under 800 ft., he would be able to make a landing. This he did, and landed without difficulty.

This flight was in sharp contrast to one that the same

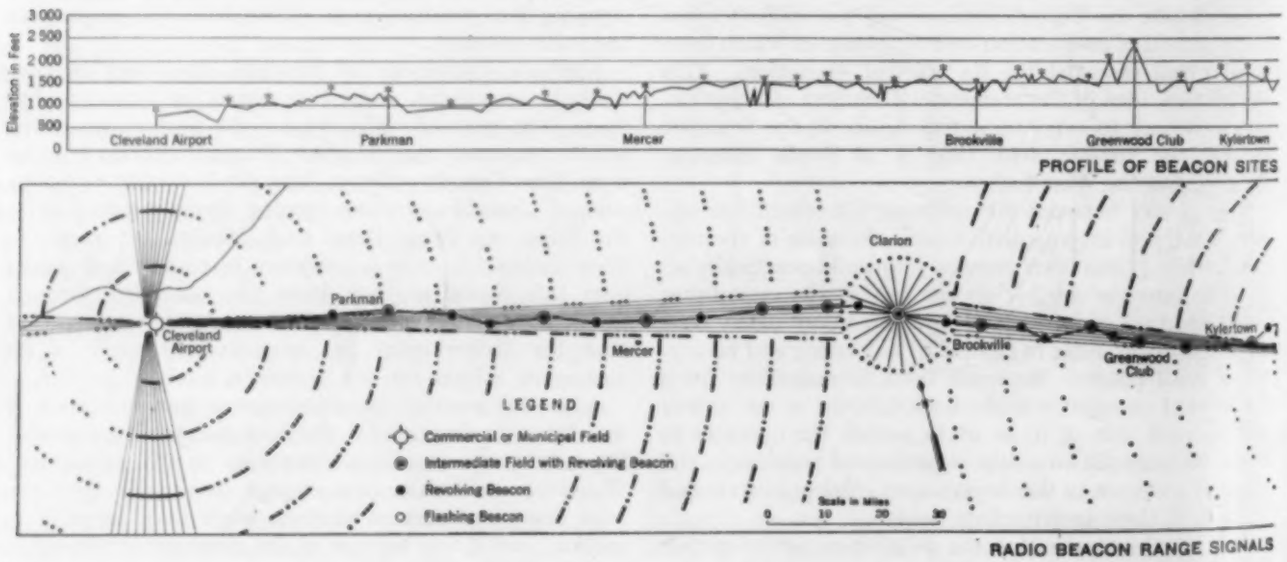


FIG. 1. MAP AND PROFILE OF THE

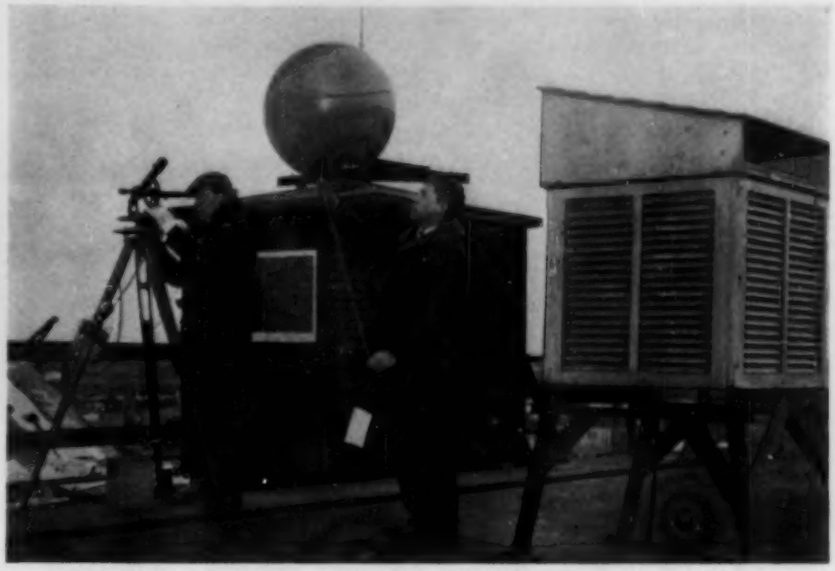
pilot had made about a year previously, before the radio was installed. Taking the mail out of Cleveland one night, he found himself flying under practically the same conditions. The first time he was able to check his position through the fog he realized that he was out over Long Island Sound. His gasoline was almost gone, but he was fortunately able to change his course due north and land in a small field in Connecticut.

After calling attention to the usefulness of the radio, it may be of interest to mention also the fact that the radio telephone system and the radio beacon system have been developed by two entirely separate organizations. The beacon system is maintained and operated primarily by the Government, while the radio telephone systems are operated largely by the carriers themselves.

Along this same airway, a radio telegraphic system is maintained, and the pilots have both receiving and transmitting sets in the planes. At control points along the way are located the company's radio operators, who are on duty 24 hours a day. These men are in touch with the planes at least three times an hour. At these times each pilot has a specific duty to make a report to these sectional control operators. At all times, therefore, the position of the planes is known. Likewise, the pilots are constantly advised of any conditions which might affect flight.

This routine may, of course, be suspended if an emergency develops or if a pilot wishes at any time to ask a station to check his position or to give weather information ahead. In fact, the giving of information to pilots while they are in flight is probably the most important function of the radio telephone system.

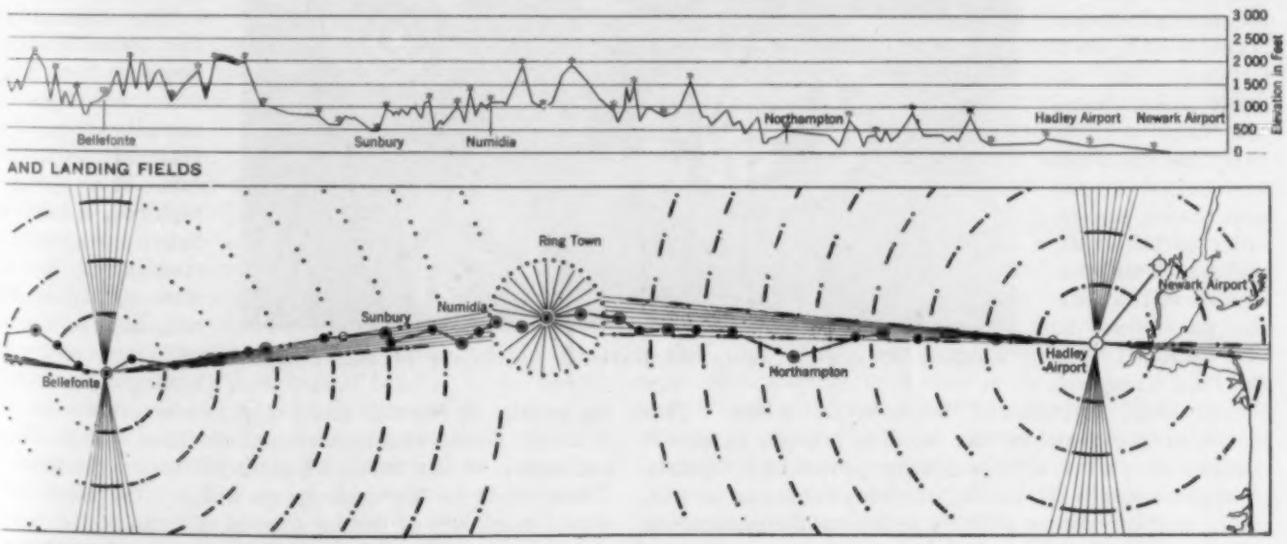
Of course, Government reports are broadcast at half-hour intervals over the beacon system. Often, however, flying conditions change rapidly, and the pilot can best eliminate the possibility of mistakes in the information by communicating with the control stations along the way and getting an absolute check on local conditions.



TAKING READINGS OF THE CONDITION OF THE UPPER AIR

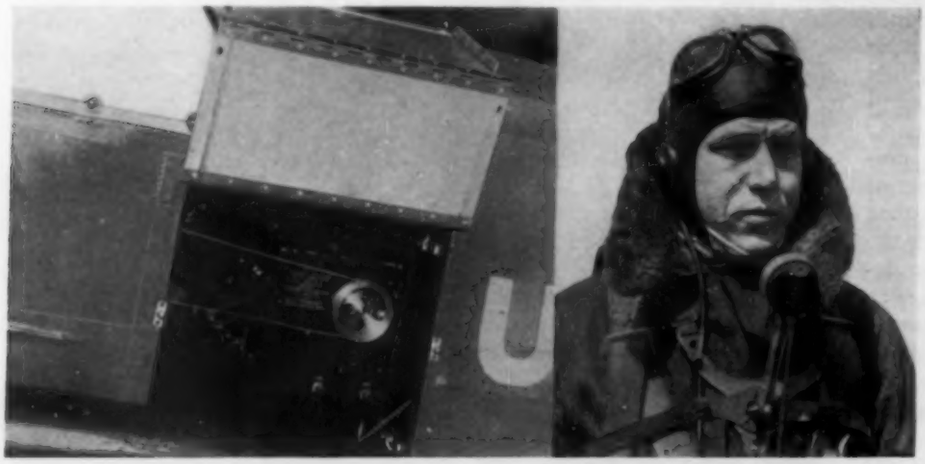
Then, if it is not safe to proceed, he can either return to a base he has passed or else change his course to some routing recommended by the control stations.

In aerial commercial transportation, the matter of pay load is important. Maintenance of the various operating facilities is costly, for at each of the fields along the routes a full crew of men must be employed to service the planes and to care for them on the ground or in flight. Until a short time ago, service over the routes was infrequent, one or two planes going each way every day. This made the overhead tremendous. Also, in Chicago, it was found necessary to maintain an overhaul and repair base which takes approximately 300 men, or about two-



NEWARK-CLEVELAND AIRWAY

thirds of the total personnel. It can readily be seen that, to pay for the maintenance of such an organization and the various operating facilities connected with it, a certain amount of traffic is required.



RADIO RECEIVING SET INSTALLATION, PILOT WEARING RECEIVING AND SENDING APPARATUS

The development of commercial aviation in the domestic and foreign fields has been predicated upon the carrying of the air mail. But operators have long realized, as has the Government, that there must be a substantial increase of traffic entirely aside from the air mail, to produce enough income to allow them to get along on a smaller mail payment. Last year Congress passed a bill called the McNary-Watres Act, which makes it obligatory for operators to carry passengers with the air mail. This, of course, necessitated various changes in airplane design, for practically nothing but cargo planes had been used in the service between New York and Chicago, as on many other lines. We then decided to fly the big Ford tri-motored transport planes, and in order to take care of the mail without inconveniencing the passengers, it was arranged that the Ford Company should build experimental boxes in the wings. This is the arrangement in use at the present time. It consists simply of a large drawer providing a capacity of approximately 200 cu. ft., in which cargo can be put, either mail or express, without molesting the passengers, who are carried in the fuselage compartment.

INSTRUMENT OVERHAUL LABORATORY, NATIONAL AIR TRANSPORT, INC., CHICAGO

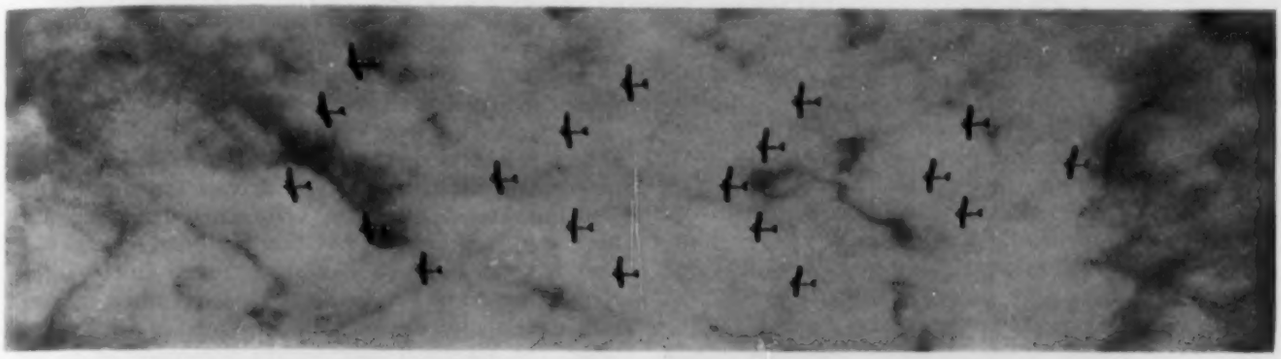
As far as passenger traffic is concerned, the present summer will probably indicate to a large extent just how valuable the revenues from such traffic are going to be. It has been our experience and that of the Stout Air Lines, which have operated a passenger service for four years, and are now a part of our company, that the one factor which prevents the building-up of a lucrative business is the interruption of service because of unfavorable weather.

If a due amount of attention is given to maintenance and operation and to the weather conditions under which flying is conducted, air transport can be favorably compared from the standpoint of safety with any other form of transportation. The building up of a lucrative passenger service depends mainly on a solution of the problem of the effect of inclement weather on schedules. It is now possible to go out with mail under certain adverse weather conditions with a fairly definite assurance of safety, but absolute security is necessary before passengers can be taken up.

Formation of ice on the plane is the most serious result of bad weather. For this reason we have been experimenting for about two years, trying to work out some thing to prevent this formation. Two scientists with whom we were working took all the data on file in Cleveland, which show that ice collects at almost any temperature under the freezing point, depending on what is known as the dew point, and after reproducing flying conditions in the Cornell University laboratory, they found that ice forms on hard surfaces much more rapidly than on very soft ones, the ratio being a very high one. A rubber fabric was then constructed but it was not entirely successful so it was saturated with oil having a low freezing point. It was still found that, under certain conditions, ice would form on any such surfaces. Then little balloonets, or air tubes, were placed under the fabric. These could be pumped up at will by the pilot and would crack any of the ice formed in flight so the wind would carry it away before a dangerous accumulation occurred.

Fortunately, these tests have proved that practical results may be achieved. Working in cooperation with one of the largest rubber plants in the United States, the company has recently had completed an entire set of coverings to fit an airplane. Underneath this rubber fabric, having a low freezing point, there is a system of air conduits or balloonets, which the pilot can control by compressed air. Test flights have shown that it is practical, and if it bears out our hopes for it, airplane transportation may shortly be proved to be just as much an all-year service as railroad or ocean travel.

There are probably two or three other developments which will affect the future of aerial transportation, among them automatic pilot control and the principle of moving wings, as utilized in the autogyro. Progress has been made, and the coming year will doubtless show that a great many of the devices which are now in the research laboratory can be proved practical.



NOT BIRDS—A BOMBARDMENT FORMATION—U.S. ARMY

The Eyes of the Army

By GEORGE C. KENNEY
CAPTAIN, AIR CORPS, U.S.A.
LANGLEY FIELD, VA.

THE history of airplane observation began when the first practical demonstration of a heavier-than-air, man-controlled craft was made by the Wright brothers, in 1903. This flight was soon followed by the organization of aviation as a branch of the military machine by practically all the great powers.

In 1907, the United States established an aeronautical division as part of the signal corps and the following year the Army bought an airplane. The French built airplanes at about the same time and, from 1910 on, used them in their army maneuvers. Germany established an army flying school in 1910 and the following year included the airplane in maneuvers. England started her military aviation in 1912. Italy, having organized aviation as a part of her army in 1910, can claim the distinction of first utilizing this new weapon in actual warfare. During the Balkan wars of 1912 and 1913, the Turks, Bulgarians, Greeks, and Serbs all used aviation, ostensibly for observation purposes.

In the meantime, military leaders in England continued to expect great things from aviation. In France, General Joffre was an enthusiastic believer in the use of the new craft. In Germany, although a large number of airplanes had been built and a number of fliers trained, the military heads of the army did not believe that aviation would be of great importance in the war that was about to come. They held firmly to the belief that ground reconnaissance was ample for their needs and vastly more trustworthy.

The outbreak of the World War found all of the combatants with some sort of air organization. About 500 airplanes of various types and degrees of unreliability were available in Europe. Germany possessed about half of this number. They were equipped with from 50- to 80-hp. engines and had a top speed of from 50 to 60 miles an hour. Most of them carried enough fuel to last two hours, and could, within an hour, reach an altitude of perhaps five or six thousand feet.

On the Russian front, the famous Hindenburg-Ludendorff team took every advantage of the information secured by the small number of planes available. But with the exception of these two, the German commanders do not seem to have made use of their observation aviation to the extent that the Allies did.

FIRST USED FOR OBSERVATION ONLY

Following the battle of the Marne, and the stabilization which resulted from the drawn battle of the Aisne, the development of air observation missions began. Up to that time, planes had been used largely for strategic reconnaissance and to locate large bodies of moving troops. With the coming of trench warfare, it became necessary to obtain detailed information of the intricate defensive systems organized on both sides.

The construction of new roads, railroads, bridges, and buildings, and the altering of the terrain by cutting down forests and constructing elaborate trench systems, soon made all existing maps obsolete. Then the aerial camera

was developed and aerial photography became a part of observation aviation.

The increased use of long-range artillery called for aircraft reconnaissance to adjust the fire, as land observation was too inaccurate and too wasteful of ammunition, as well as too slow. Radio sets were developed and installed, and the artillery airplane, equipped to communicate with the ground, took its place in warfare.

In the spring of 1916, the infantry airplane, as it was called by the Germans, was assigned the mission of maintaining liaison between a commander and his assaulting units, to furnish him with information as to the movements of both sides in his sector.

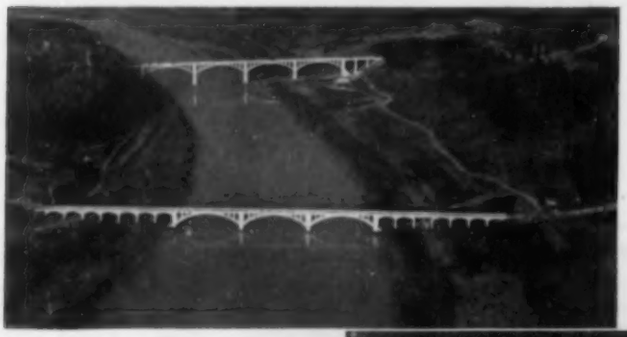
During the early phases of the World War, the airplane was looked upon solely as a means of reconnaissance, supplementing and extending existing means. Opposing aviators occasionally blazed away at each other with shotguns or revolvers but, as a general rule, they waved a comradely greeting or shook their fists at each other, depending on their nationality and how they felt about the war at the moment. But those days, when motor failure was the only worry, did not last long. The need for interference with, or prevention of, the enemy's air observation soon became apparent, and anti-aircraft ground defenses were installed. Smaller airplanes were sent out for the express purpose of shooting down the slower and less agile enemy aircraft, and to keep enemy fighting planes from bothering friendly observation.

MACHINE GUNS MOUNTED

For the Germans, Anthony Fokker invented a mechanical interrupter gear to be used on a plane, which was synchronized so that a machine gun could shoot through the propeller without the bullets hitting the blades. The Allies soon copied and improved this type of plane. The Germans called these planes "chasers;" the British referred to them as "scouts," and later as "fighters;" while the French used the term "chasse," which we have translated as "pursuit."

By 1915, developments in the design and motors of planes had resulted in a type of craft that could carry something besides the crew and enough fuel to stay up for a couple of hours. Aviation then had another aim, that of attacking those on the ground from the air. Regular air bombs of streamlined shape, fitted with tail fins, were manufactured and put into service by both sides. At least half their weight was made up of high explosives, but none of them was of sufficient size to destroy a substantial target as they weighed, in general, from 17 lb. to 225 lb. Toward the end of the war, larger bombs were made and airplanes designed to carry them were produced, but the signing of the armistice prevented their getting a real service test.

Although the desirability of using light bombs and machine-gun fire from airplanes against human and other small targets was recognized early in the war, the formation of separate units for this purpose did not take place until the spring of 1918, when attack aviation began. At this time, Ludendorff was preparing for Germany's final effort to break through the Allied defense and thus gain a decision. He concentrated his best shock divisions, increased the number of machine guns and trench mortars, brought up enormous quantities of artillery and gas shells, and, finally, organized and concentrated one-half of Germany's total air strength on the 30 miles in front of the



An Air Attack on a Reinforced Concrete Bridge

During 1927, a unique opportunity was presented to make tests of destruction on a modern reinforced concrete arch bridge. Due to changes in the hydraulic use of the Yadkin River, N.C., also called the Pee Dee River, the bridge here illustrated was to be inundated in the reservoir formed in the development of the river. The report of the extensive tests by a committee, on which the Society was officially represented, is to be found in PROCEEDINGS for March 1929, page 608. A new higher level bridge replaced the structure shown here.

This unprecedented opportunity for large-scale tests was eagerly seized by engineers. Experimental work proceeded under the joint auspices of the North Carolina Highway Commission and the U.S. Bureau of Public Roads.

After experimental tests had been concluded, the Air Corps was assigned one-third of the bridge as a target, and the remainder was to be destroyed by artillery fire and by statically exploded charges of high explosive. The pictures show: (1) the bridge before the aerial attack; (2) a direct hit by a 1,100-lb. aerial demolition bomb; (3) the destruction after the attack. Most of the damage was done by three 1,100-lb. bombs which destroyed four approach spans and displaced a river pier sufficiently to tear the deck loose. This illustrates a typical line-of-communication target for the Air Corps.

British Third and Fifth armies. There the German Seventeenth, Second, and Eighteenth armies hoped to drive a wedge through Amiens to the English Channel.

On the opening day of the drive the expected results were realized. The German pursuit planes led by the famous Baron von Richtofen, dominated the air over the front and the attack planes worked on schedule. British and French planes of all types were rushed to this front from every direction, and by March 25 they had regained control of the air situation. Although the Allies had no attack aviation, they diverted everything they could spare for that purpose and conducted continuous attacks on the German troops. In his official history of the war, Cutlach says: "It was known later that the airplane attacks affected severely and perhaps decisively the success of the German offensive."

Lacking an airplane especially constructed for attack work, the Allies during the remaining few months of the war constantly diverted other types to this work, sometimes with considerable success.

GREATER USE FOR PLANES

At the end of the war all the military powers began to study the application to modern warfare of aviation, the new weapon that had been developed. Many noteworthy accomplishments in air warfare had been carried out, but the hurried development had given little time for a study of tactics and many of the achievements made were largely a matter of luck. The problem was how, by study, to make successful results more certain of accomplishment.

Aviation had shown itself to be a new weapon of warfare, functioning in a new way, and carrying out operations heretofore impossible to the commander of field forces. Although the basic principles of war were not changed by the introduction of the airplane any more than they were by the introduction of any other new weapon, the methods of applying those principles were revolutionized.

There is no question nowadays of the importance of air observation in the minds of the military leaders of any country. In the German official history of the war we find the following comment: "The conduct of any military operation of the future without air observation and without air intelligence for the planning of that operation is inconceivable."

A French military writer has stated: "Observation aviation is of prime importance to the ground forces. Without it the high command is blind, the artillery is unable to locate suitable targets and adjust its fire, and the infantry cannot maintain proper liaison with its supporting artillery, nor make known its needs."

IMPORTANCE OF AIR FORCES

The operations of the Air Corps in cooperating in attacks on hostile lines of communication and supply, and on concentration centers, on munitions factories, and on airplane factories and depots, has become closely tied up with the maneuvers of the ground forces. In fact, without aviation, the ground forces cannot hope to successfully engage in a war against an approximately equal adversary who possesses aviation. It has become almost a military axiom that, under conditions of modern warfare, no military operation of any magnitude, whether it be attack, defense, pursuit, or retreat, can be successfully carried out if the opposing force has air supremacy.

Observation aviation has the task of furnishing information of the enemy to the friendly front-line units; to friendly artillery; to commanders of divisions, corps, armies, and to general headquarters; and to its own air force, so that targets can be selected for bombing and attack operations. Observation work is divided into three classes: high-altitude distance reconnaissance missions; flights of low and intermediate altitude—short penetrations of the enemy's territory for the corps or the division; and night reconnaissance.

To carry out these tasks the Army reconnaissance airplane has been designed. It is a three-seated, two-engine craft carrying a heavy mapping camera, and equipped with superchargers with fuel enough to carry it 300 miles into hostile territory and back, and the ability to go to an altitude of 25,000 ft. to avoid the dangers of hostile anti-aircraft fire and enemy pursuit. The corps observation airplane, light and very fast, a two-seated, single-engined machine, does the work for the corps and divisions.

For night reconnaissance missions, a modification of the Army observation airplane is used. Night observation is conducted at fairly low altitudes, from 500 to 3,000 ft. To assist the pilot and observer in picking up details on the ground, a number of pistol flares are carried which illuminate an area 500 yd. in diameter from an altitude of 1,000 ft. The light burns for about one minute. Night navigation is conducted by following natural landmarks and is assisted by radio beacons and light signals at stations along routes to and from the front.

USES OF BOMBARDMENT PLANES

Bombardment planes are often supported by attack planes, which neutralize the anti-aircraft defenses on the ground; and by pursuit planes, which keep enemy pursuit planes from interfering with the success of the bombardment mission. The bombardment plane used by the Air Corps today is a two-motored, four-seated plane with a speed of approximately 130 miles per hour and a bomb load of 2,000 lb.

Attack airplanes are of light construction, two seated, and capable of 150 miles an hour. They are able to carry 400 lb. of bombs and 9,000 rounds of machine-gun ammunition, which they can dispose of in about 30 sec.

Four guns, shooting toward the front with a total rate of fire of approximately 4,000 rounds per minute, enable them to hold down hostile rifle and machine-gun fire and to get in close enough to drop their bombs. These bombs are either the small 25-lb. fragmentation type, or the 100-lb. demolition type, which will destroy a hangar, a wooden bridge, or a light steel bridge.

The primary missions of attack aviation are to interfere with troop and supply movements, to attack troops in bivouac, and to destory hostile airdromes. Large masses of from 70 to 80 planes operate during the daytime, flying at extremely low altitudes, and sometimes supported by friendly pursuit aviation. Attack aviation is also charged with the support of bombardment attacks, by neutralizing or destroying enemy anti-

aircraft establishments in the vicinity of the target. Some of the supporting planes carry tanks of liquid smoke which they spray up wind. This smoke drifts down over the known or suspected anti-aircraft gun positions and blinds the gunners until the bombardment planes have completed their work and are on their way home.

The pursuit airplane is the fighter. Its mission is primarily to destroy other airplanes in the air. During the greater part of the World War the story of pursuit aviation was the story of the individual pilot operating by himself. Today the work of the pursuit plane has changed. Pursuit planes now operate in masses of from 70 to 80, echeloned in depth from perhaps 10,000 to 20,000 ft., so that they cover a large area and at the same time are capable of attacking quickly, by diving into position. When escorting other aviation, they remain within supporting distance so that they can prevent hostile pursuit planes from engaging the unit that they are supporting.

Aviation has become a necessary part of the military organization. At the outbreak of a war a strong aggressive air force can cause a tremendous amount of destruction. It is necessary, therefore, to maintain sufficient air strength in time of peace to act as a barrier to hostile air attacks until other forces can be brought into play.

Aviation Facilities on Naval Carriers

By KENNETH WHITING

CAPTAIN, U.S.N., COMMANDING U.S. NAVAL AIR STATION
NAVAL OPERATING BASE, HAMPTON ROADS, VA.

AMONG the pioneers in the development work of aviation were the late Commander T. Gordon Ellyson, the late Capt. John Rogers, and Capt. John Towers, U.S.N., now Assistant Chief of the Bureau of Aeronautics. Their experiments prominently included launching planes from and returning them to ships at sea.

In order to launch planes from aboard ship they must be accelerated rapidly so that they will take the air in a short distance. The Navy had two problems to solve; one was to get the planes into the air, and the other was to get them back aboard ship.

The Navy started its aviation studies aboard ship in 1910 and 1911, when Capt. W. I. Chambers, U.S.N., was put in charge of Naval Aviation. A 250-ft. platform was built on the old U.S.S. *Pennsylvania* and, in 1911, in San Francisco Bay, Mr. Ely—a nephew of Maj.-Gen. Hanson E. Ely, 2nd Corps Area Commander, New York—made the first successful flight ever made from any ship. For landing, the axle of the plane was fitted with hooks that caught onto wires on the platform. To these wires sand bags were attached. The United States thus gained the credit of making the first landing on, and the first flight from, a ship.

One method experimented with to get a seaplane aboard was to land the plane on the water, taxi it alongside the ship, and hoist it on deck. But the water was often too rough for the flimsy planes then in use. So, in 1911, an amphibian was developed that could land either on the water or on the platform of a ship.

In an effort to avoid the building of landing platforms which would interfere with gunfire, an attempt was made to launch a plane by running it down an inclined wire attached to the mast, until it gained flying speed. A flight was actually made at Hammondsport, N.Y., from a wire 280 ft. long, inclined at an angle of about 25 deg. However, this device was soon abandoned. It was not practical because it required the hoisting of the planes up the mast, thus subjecting them to the roll of the ship and to winds from all directions.

At Annapolis, the first launching by catapult was unsuccessful and the plane dove into the water. The pilot, Lieutenant Ellison, was not hurt. At the Washington Navy Yard a seaplane was fastened to a car and successfully launched from a float. The car went overboard but the plane took the air.

Later, with a 30-ft. run, a plane piloted by Lieutenant Ellison was projected into the air by means of a small air cylinder operated by from 500 to 600 lb. of compressed air. A specially designed valve allowed the pressure to be built up in the cylinder quickly. On the first attempt, the valve was installed backward and, although the plane took the air, the rapid acceleration of about 2 G gave the pilot a very stiff neck for several weeks afterward. The catapult run was then increased to 50 ft. With the acceleration reduced to about $1^1/_2$ G, there was practically no jerk, and a plane left the catapult car in $1^1/_2$ sec. Every pilot at Pensacola was required to qualify for this method of launching.

During these first experiments, the catapult car had gone overboard on each launching. A later development was the stopping of the car by a recoil mechanism similar to that used on a gun. To keep the air pressure down, the car was made light in weight, but strong enough not to be damaged when stopped in about 10 ft. In the first experiments, the cars were broken against the recoil mechanism, and then, when the cars were made heavier, the recoil mechanism was wrecked. It was a constant battle between the two.

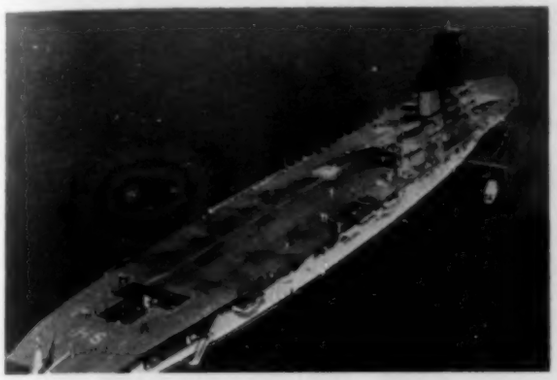
During 1915 the catapult principle was first tried for the launching of planes from aboard ship. These first catapults, which were 105 ft. long, were centered on the top of a turret, which formed the turntable. At the time of our entry into the World War, four ships, each capable of carrying six planes, were equipped with catapults.

So great was the wartime necessity for troop ships, cargo ships, and provision carriers, and for convoys, that no ship could be obtained to continue experimental work. Since the catapults interfered with gunfire,

these were removed from the few ships which had already been so equipped.

Near the end of the war, the British used a portable platform which was strapped to the guns and could be taken off in a period of about a minute. It gave a 70-ft. run. To enable a plane to take off under its own power, a device was developed which held the plane until the engine was running at full speed and then quickly released it. The plane was released into the wind by pointing the turret.

Four of these portable platforms were put on four of our battleships. Of course this step met with strong objections from the Bureau of Ordinance, since the guns



THE H.M.S. HERMES—BRITISH CARRIER
The First Ship Designed and Built as an Aircraft Carrier

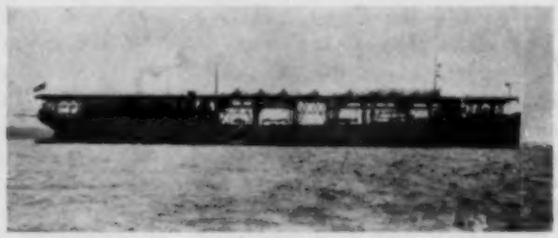
were not designed to carry such a platform. The officer of the deck also objected because the housing of the plane on deck blocked his vision forward. This method was therefore abandoned.

After considerable discussion by the General Board, air-pressure catapults of the turntable type were installed on most naval vessels. These catapults permit a plane mounted at one end to be pointed into the wind without the ship's changing its direction or dropping out of formation. Now all light cruisers and some of our battleships are equipped with this type of catapult, with two planes on the old light cruisers, six on the new light cruisers, and four on each battleship.

The Navy's latest and most efficient catapults use gunpowder to develop the necessary acceleration. A small charge of powder is fired in the cylinder. When the pressure reaches a certain value it automatically operates a valve and begins to move a piston. The piston, in turn, is connected with a cable which goes over a head sheave along the top of the catapult and is attached to a car, on which the plane is secured. Most of our battleships are equipped with this type of catapult.

The British carrier, H.M.S. *Hermes*, 565 ft. long, is the only ship in existence which was built from the keel up as a carrier. It is equipped with T-shaped elevators both fore and aft and is of the island type, that is, the smoke stack and the bridge are on the starboard side and the rest of the deck is clear runway. Planes normally take off from the *Hermes* without catapults.

The island type is proving a most satisfactory carrier. After the war, the United States Naval Aviation was assigned the U.S.S. *Jupiter*, a converted collier, 560 ft. long with 65-ft. beam. To date, 10,000 landings have been made on this ship with no fatal accidents. She was renamed the U.S.S. *Langley*, is a flush-deck carrier, and has stacks which fold outboard. A plane can take off from her deck against a 20-mile head wind in 90 ft. Her retarding gear is about 250 ft. long. The after end of the flight deck is curved downward slightly so that it is hardly possible for a pilot in landing to fly



U.S.S. LANGLEY, THE NAVY'S FIRST AIRCRAFT CARRIER
A Flush-Deck Type

into it end on. If he flies a little too low and his wheels hit this lowered part of the deck, he strips his landing gear, bounces into the air, and slides aboard. The *Langley's* full quota of planes is 36.

The U.S.S. *Saratoga* and the U.S.S. *Lexington*, both island-type carriers, are sister ships, 888 ft. long with a 106-ft. beam. They are capable of making 35 knots and developing 200,000 hp. Both these ships were intended originally to be battle cruisers. Each ship can carry and operate 100 planes. Since the top of the elongated stacks is 125 ft. above the water, smoke is not troublesome and the only problem is that of supplying enough air to burn the oil needed in developing the 200,000 hp.

On these carriers, torpedo seaplanes are launched by catapult so that a 11,000-lb. bomber is enabled to leave the deck at a flying speed of 55 miles per hour. In the 50-ft. drop to the water the plane has an additional

U.S.S. SARATOGA CARRIES AND OPERATES 100 PLANES
200,000 Hp., 35 Knots, 888 Ft. Long

opportunity to pick up speed. The catapult car is stopped in 14 ft.

A carrier such as the U.S.S. *Saratoga* is very vulnerable to gunfire, but with its high speed, 35 knots, and the speed of its planes, there is no reason why it should be subjected to direct attack. By naval treaty the United States is entitled to seven airplane carriers, having a capacity of 100 planes. The planes carried on light cruisers and battleships bring the total up to nearly 1,500 planes that can be put into the air on short notice.

The Utility of Geodetic Control Surveys

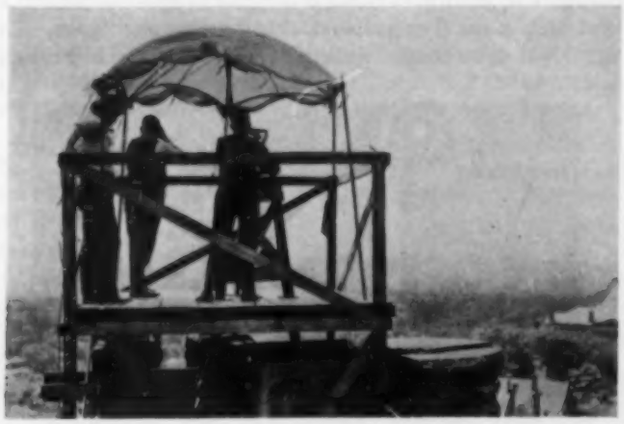
By R. S. Patton

Member American Society of Civil Engineers
Director, U.S. Coast and Geodetic Survey

CIVIL engineers are familiar with the methods used in carrying on the work of control surveys, with the standards of accuracy maintained, and with the improvements made in instruments, equipment, and processes. In this paper, however, Mr. Patton deals with a new aspect of the subject—the usefulness of such surveys, when completed, to the individual engineer and to the community. Besides making it possible permanently to locate national and state boundaries, modern topographic mapping is an invaluable tool for the city or regional planner, and it has many other uses both for the property owner and for the engineer. This article is an abstract of the paper presented before the Surveying and Mapping Division on April 16, 1931, at the Norfolk Meeting of the Society.

WHEN the Coast and Geodetic Survey has done its part, where do we stand? Control surveys are not an end in themselves; they are merely a means toward many ends. They are a tool for the engineer's use and, like any other tool, they are of value only to the extent that they are used. Sooner or later, control surveys are certain to find their proper place in engineering work, but the process of adoption will be accelerated if the engineer can be given a clearer and more definite picture of the situation.

The aspect I have chosen is a difficult one to handle. To speak authoritatively on the relationship between two different subjects, the speaker must know both subjects equally well. The last word on the place of control surveys in regional development, for example, can be spoken only by the man who is both an expert geodesist and an expert city planner. That person is as yet a purely hypothetical one, and we must grope our way through this formative period as best we can without him.



Triangulation Station Erected on a City Building
Separate Structures for the Observer and for the Instrument

For the following reasons control surveys are of value to every enterprise requiring exact knowledge of the dimensions and configuration of an extensive portion of the earth's surface: (1) they insure accuracy in the operations based on them, and at the same time reduce the cost of such operations; (2) they provide a means of coordinating the results of one project with those of other adjacent projects executed either concurrently or at different times; and (3) they enable the relatively simple principles of plane surveying to be applied to operations in regions so extensive that the curvature of the earth must be taken into account.

Preserving Property Boundaries

Perhaps the most important non-Federal use to which control surveys can be put is in the definition and preservation of property boundaries. By furthering the security of land tenure, control surveys contribute to national stability, but the extent of this contribution can be greatly increased. The latest survey along one of our international boundaries—that is the boundary between the Lake of the Woods and the Pacific Coast, following the 49th parallel of latitude—is controlled by precise triangulation. This boundary is well monumented and the positions of the markers are defined in terms which will permit of their accurate restoration should any of them be destroyed. Our other international boundaries are also in very good condition but they have not been controlled by precise triangulation.

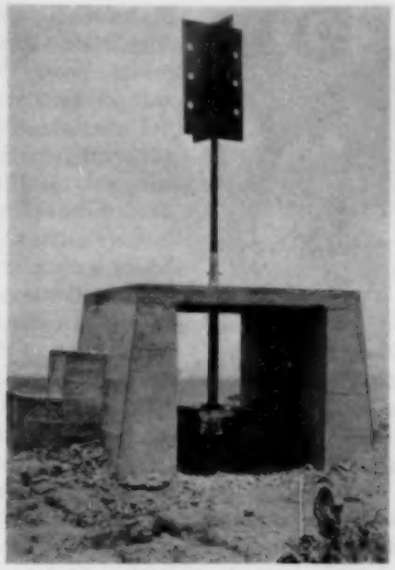
State officials are beginning to realize the importance of accurate triangulation as a means of establishing state boundaries along given meridians or parallels. A section of the boundary between Texas and Oklahoma, along the Red River, was based on surveys which were dependent on first-order triangulation. Another part of this boundary, along the 100th meridian, was located by means of first-order triangulation. I feel confident that accurate triangulation will be used to a very great extent to settle future boundary controversies. In order to give accurate and final positions to state boundary monuments, the engineers of the U.S. Coast and Geodetic Survey are, wherever it is practicable, making connections between existing boundary monuments and the first-order triangulation. This is about the extent of our progress to date.

It is not yet generally realized that the considerations making it desirable for a state boundary to be tied to the Federal control surveys apply equally in principle to the boundaries of a county, township, farm, or city lot. Yet such is the case, and one of the lines along which the Surveying and Mapping Division might well exert its influence is in spreading this idea.

The present system of delimiting property is based on the belief that a point on the earth's surface can be perpetuated by placing on it some physical object for a marker. Many centuries ago the Egyptians learned the fallacy of that theory, but we still adhere to it. In a recent city improvement project, a base-end monument of massive concrete was lifted out of the ground by

a steam shovel and placed aside even before the surveying party could reach a tape to it. If a monument like this is impermanent, what hope is there of an enduring future for the stake, the pile of rocks, or the blaze on a tree, which commonly mark farm boundaries?

The early surveys were notoriously inaccurate. Fifty years or more ago, a surveyor who owned a Gunter's chain and a peep-sight compass on a Jacob's staff was better equipped than were many of his fellows. Angles were recorded —I will not say measured—to the nearest degree or half degree, and frequently there was no direct evidence as to whether the variation of the compass had been taken into account. Distance measurements were equally crude and unreliable. Finally, it was a common practice not to close the traverse. Today there are many deeds on record in which a description by metes and bounds encircles the greater part of the tract and, having run to a spot somewhere in the vicinity of the origin, closes with the phrase "and thence to the place of beginning."



STATION MARK AND PERMANENT SIGNAL
On a Station Punchbowl Near Honolulu, Hawaii

Because of these inaccuracies, it has come to be the well established court practice that the actual positions of the boundary marks on the ground, if they can be established with reasonable certainty, shall control the metes and bounds of the survey. The situation is particularly bad in the old Colonial States, where there is frequent litigation between property owners over the location of their boundaries. I am sure that the cost to the citizen of an accurate control survey of a state would be less than the cost of court procedures. Reduction in property values also results from defective titles.

The surveyors of a century ago should not be criticized for employing the methods of their day. Land was cheap —in some cases a few dollars or even a few cents an acre. Necessarily, any cost of a survey above the minimum necessary to give a general idea of the outline of a piece of private property, was uncalled for. However, with our present great increase in population, land has become more and more valuable.

USE OF CONTROL SURVEYS IN CITY PLANNING

In addition to their value in topographic mapping, control surveys may be applied to city planning. The recent national census indicates that our population is predominantly urban; and this tendency toward city growth has challenged the attention of all thoughtful persons and compelled widespread realization of the fact that if the cities are to continue to maintain their capacity to receive and assimilate the future influx, the trends of growth must be carefully directed and controlled.

In making recommendations relative to a city plan for Pittsburgh, Frederick Law Olmsted pointed out the fact that no city of equal size in America is compelled to adapt its growth to as difficult a combination of high ridges, deep valleys, and precipitous slopes as is this city. Consequently, the need of accurate and comprehensive surveys is great and the lack of them has resulted in much confusion and expense.

According to Mr. Olmsted, the tapes used in the original surveys of Pittsburgh differed in length and the errors were never compensated. Discrepancies in elevation of several feet, and sometimes of unknown amounts, occur in the records of adjacent or intersecting streets. Also, boundary lines are so poorly defined that the city often has no sure recourse against abutting owners who have encroached on a street. The blame for all this, Mr. Olmsted states, falls upon the whole system of hand-to-mouth procedure in regard to city surveys that has been characteristic of a large proportion of American cities in the past. Quoting from his recommendations:

"An accurate framework of reference points needs to be established, including: (1) the gradual systematic setting of permanent street monuments throughout the city, to serve as reference points for the definite determination of street locations and for all public and private local surveys; (2) the accurate determination of the locations and elevations of these and other monuments and bench marks in reference to a single general system of coordinates and the U.S. Government bench; and (3), as a means of accomplishing these ends, an accurate geodetic triangulation of the district. . . .

"The existing local surveys and records need to be tied into the accurate framework thus established, and in cases which show deficiencies or discrepancies beyond a reasonable and carefully defined standard of accuracy, they need to be gradually, in due turn, resurveyed and replotted.

"Complete topographical maps, based upon the framework first described, should be prepared upon some uniform system, beginning in those sections where public works are immediately contemplated and gradually extended so as to cover the whole area into which the city's growth is likely to spread."

Engineers who specialize in city planning are well aware of the general application of Mr. Olmsted's comments, and I believe that hereafter few city plans not based on accurate and intensive control surveys will be used. It is worthy of note that an accurate topographic map for Pittsburgh and its environs is rapidly nearing completion.

SMALL PROPERTY SURVEYS

Much confusion has existed in the minds of some engineers as to how a city lot or a farm can have its boundaries located by triangulation. Really the problem is not difficult. In making the property survey for a single lot or farm, the engineer should not be required to incur the expense of making a triangulation for the individual job. State and city officials should see to it that there are triangulation stations placed within a

comparatively short distance of each piece of property.

An engineer making a survey for a city lot would go to the nearest one of these traverse or triangulation stations, sight on some other station or object whose azimuth had been determined, and then traverse to the city lot. It is not a difficult operation, and if high-grade transits and accurately graduated tapes were employed, any desired accuracy could be secured. The engineer

MEASURING A TRAVERSE LINE OVER CITY STREETS

would merely use the same principles that he now employs in traversing to the corners of a lot. The only difference would be that he would correct his measurements in order to eliminate such effects as grade and temperature. By this refined method he could locate his corners within a very small fraction of an inch.

In locating the corners of private property, the local surveyor or engineer should not even need to use latitudes and longitudes. Each county, or sometimes a group of counties or a city, should have its system of plane coordinates. By using this system, the elementary principles of plane trigonometry could be employed in the boundary locations and in the recovery of boundary monuments. It is a very simple matter to transform spherical coordinates, in the form of latitudes and longitudes, to plane coordinates designated x and y. In fact, the plane coordinate system is the more logical one and it is certainly much easier to apply. Necessarily, if cadastral surveys are to be made over a large area, such as that of one of the larger states, it would be impracticable to have a single plane coordinate system for the entire area; it must be broken up into sections. However, this system can be used in any city.

It seems to me that the engineers of each state should come to an agreement as to just what plane coordinate system should be adopted. After this system has been put into effect and the boundaries of the state properly defined, a record in the state's land court should show the relation between x and y coordinates and the longitudes and latitudes of certain triangulation stations, so that there would never be any doubt as to the exact location of any boundary monument. Should all the monuments within such a system be destroyed, their positions could be recovered by working from the triangulation stations used in establishing the control points of the plane coordinate system.

It would be advantageous for each state to have a land court, in which all disputes over property boundaries could have a hearing. Since laws relating to the ownership of property are very complicated, it is reasonably certain that such a court, designated to concentrate on boundary matters, could render decisions more expeditiously than one in which the officials were not experts on property matters.

Some years ago, Massachusetts enacted a law providing that private property boundaries be connected with the horizontal control system of the state. The township lines were connected with the triangulation, and monuments were set on these lines, where they are available to the engineer who undertakes a boundary survey. Even before Hawaii was annexed to the United States as a territory, its government decreed that triangulation should be extended over the islands and that private property boundaries should be, wherever practicable, connected to the triangulation stations.

I am now advocating that the Nation adopt cadastral surveying methods comparable in scope with those adopted by Hawaii and the State of Massachusetts. To put into effect such a cadastral system will, of course, involve a large expenditure, but there are some expenses which a state or an individual cannot afford not to incur.

As to the leveling system in this country and the uses to which it can be put, every engineer knows that if his work does not stand apart from all other pieces of work, he must have an elevation that is referred to some common datum. In the United States there are now some 65,000 miles of first-order leveling and a few thousand miles of second-order leveling. This work is being extended rapidly, and it will be only a short time before the Federal net will be completed and there will be few, if any places more than about 25 miles from a first- or second-order bench mark.

The Federal officials responsible for control surveys and topographic mapping have been required in the past to try to forecast the needs of the users of Federal survey and map data. If the bureau has made mistakes, it is not through any lack of desire to serve the public. At least half the difficulty is due to a lack of cooperation on the part of the public. If national progress sufficiently changes the basis on which certain projects were formulated, the projects themselves should be modified accordingly. Among our pleasantest days at the U.S. Coast and Geodetic Survey are those when competent engineers drop in to talk over the work.

LACK OF CONTROLLED SURVEYS CAUSES WASTE

We have had so many contacts with engineers and others who call upon us for survey and map data that we have the idea that our surveying and mapping are not progressing as rapidly as they should in order to eliminate waste in many fields of activity. We cannot measure this waste but it is surely there. On the other hand, the cost of the maps and surveys is sadly apparent, because the amounts spent on them are included in a formidable "Budget Report" and in an appropriation act by Congress. However, it is not realized that the total expenditure has been small and that today, in spite of our intensive national development, less than half our area has been surveyed for the topographic map.

The bureau is, then, faced by various problems in the matter of control surveys, and it looks to the engineer for cooperation in the solution of them. It feels, also, that the Society has a numerical strength and a professional standing which justify it in acting as a spokesman for the civil engineering profession of the country.

Surveys for River Studies

A Nationwide Study of the Rivers of This Country

By GERARD H. MATTHES
MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
PRINCIPAL ENGINEER, U.S. WAR DEPARTMENT, AND CHIEF OF HYDRAULIC DIVISION
U.S. ENGINEER OFFICE, NORFOLK, VA.

AS the result of various acts of Congress, the United States is now witnessing the most extensive and exhaustive series of river investigations ever undertaken in its history. About 250 rivers are included, and the total appropriations for the work amount to approximately $13,000,000, every dollar of which is intended for investigations and surveys to the exclusion of any construction work. These extended surveys are for the purpose of coordinating improvements for navigation, flood control, water power development, and irrigation. The paper by Mr. Matthes, here abstracted, was read before the Surveying and Mapping Division on April 16, 1931, at the Norfolk Meeting of the Society. Detailed descriptions of individual surveys of this type were given on pages 258 and 263 of the January issue of CIVIL ENGINEERING, *by L. D. Worsham and George R. Clemens.*

IT is a recognized function of the Federal Government to engage in the construction of works for the improvement of navigation and for the control of floods. The first attempt on the part of Congress, looking toward a comprehensive development of our rivers, found expression in the Act of 1910. The Federal Power Act was passed in 1920. Certain defects in these acts led Congress, in 1925, to direct the Secretary of War—through the Corps of Engineers, U.S. Army—and the Federal Power Commission, to jointly submit an ". . . .estimate of the cost of making such examination, surveys, or other investigation, as, in their opinion, may be required of those navigable streams of the United States and their tributaries, whereon power development appears feasible and practicable, with a view to the formulation of general plans for the most effective improvement of such streams for the purposes of navigation and the prosecution of such improvement in combination with the most effective development of the potential water power, the control of floods, and the needs of irrigation. . . ."

On April 12, 1926, the resulting report was submitted to Congress, and was published as House Document No. 308, Sixty-ninth Congress, First Session. It recommended an examination of 180 rivers, involving an expenditure of $7,300,000. It called for logical plans of development such as would lift many of our rivers out of the category of national liabilities into that of public assets. Initial appropriations for the work of the rivers listed in Document 308 was made on March 23, 1928. In addition, the flood control acts of May 15, 1928, and February 12, 1929, provided for flood control investigations on all tributaries of the Mississippi River subject to destructive floods, and on other streams, and authorized expenditures exceeding $5,000,000 for this purpose.

The unprecedented impetus that has been given of recent years by Congressional action to the study of our rivers, with a view to coordinating improvements for navigation, flood control, water power development, and irrigation, has brought about a type of river survey that differs radically from the older, more conventionalized type.

River surveys are usually made with restricted funds and with personnel as a rule trained in engineering rather than in surveying operations. Special emphasis must be laid on the fact that these surveys differ fundamentally from those made by Federal bureaus whose sole business it is to make cartographic surveys. In the case of the Engineer Offices of the War Department, in charge of rivers and harbors, the personnel must perform a great variety of tasks, no two engineering problems or surveys being alike.

Every river, estuary, and harbor is a law unto itself. The problems and surveys arising in connection with each require individual treatment. Methods must be varied to suit not only the physical aspects of each case but also the requirements of Congress with reference to the time and funds allowed.

It is doubtful whether the accuracy specified for cartographic work promulgated by the Federal Board of Surveys and Maps can be considered applicable to this class of surveys. In certain cases where large areas must be mapped or extensive leveling operations must be carried out, the limits of error prescribed by the Federal Board are useful. In other respects, the accuracy to be attained necessarily becomes a matter of judgment on the part of the officer charged with the execution of the surveys. Instances occur where the accuracy must exceed that set by the board, and also where precise work would be a mere waste of funds. Both conditions may occur within one and the same survey. Hence it is often necessary to vary the accuracy requirements in different parts of a single survey, a procedure contrary to the best practice in cartographic surveys.

As a rule, a good profile is of far greater importance in a river study than an accurate map. At any rate, more often money spent on securing data for a full and comprehensive profile will be a better investment, where funds are limited, than the preparation of maps. It is seldom necessary to have an accurate map showing an entire watershed of a river. Such information as relates to drainage areas, areas in forest, under cultivation, or in marsh, is not susceptible of determination with any great exactness, no matter how accurate a survey may be executed, nor does precision here serve any useful purpose. On the other hand, considerations relating to the hydraulics of rivers, their regulation, rectification, and channel deepening, demand accurate profiles and channel surveys, supplemented by special surveys of dam sites and reservoir sites. In most studies where the river channel and valley lands are of immediate impor-

tance and fairly complete strip maps are needed, aerial photography affords the best means. Up-to-date maps, using the word in the cartographic sense only, made by the U.S. Geological Survey and the U.S. Coast and Geodetic Survey, will answer all requirements of river studies in so far as general map information is concerned.

Surveys under House Document 308 have been notorious for the many different engineering aspects that they involve. Measurements or surveys in one form or another are called for in the determination of the following, which constitute only part of the work to be done under 308 surveys.

Navigable depths, tidal ranges, low-water and high-water profiles, and sediment deposits, both in navigable reaches and in existing reservoirs; geological formations at dam sites and under reservoir basins; flood heights, the extent and nature of flood damage, and flood-control possibilities; water power and storage sites, and their probable effect on navigable depths, flood heights, and water power; back-water effects caused by dams during floods; stream-gaging operations, establishment of gages, and velocity determinations.

Much resourcefulness and general knowledge of streams and the various uses to which they may be put is required on the part of the field personnel engaged on such surveys. One of the most difficult matters confronting both field and office personnel is to reconcile the mass of data from previous surveys made for widely differing purposes by the Government, by states, by railroad and power companies, and by private interests.

In some river basins, absence of standard topographical quadrangles has made it necessary to map large areas. The resulting maps may become of value for incorporation into the general mapping program of the country at large but, aside from such instances, river surveys are not intended to contribute to such a program.

VERTICAL DIMENSIONS MOST IMPORTANT

A river, as a physical unit or structure, from the point of view of the hydraulic engineer, is possessed of more than three dimensions. Vertical dimensions are of several kinds, not directly related, and are of first importance in hydraulic considerations. Horizontal dimensions need not be determined with any great accuracy, being of relatively minor importance. Good vertical control is essential in any survey that is concerned with the comprehensive development of a river and its major tributaries. Navigable and tidal waters require a higher order of accuracy than do the upper, non-navigable reaches.

Horizontal control is of importance in estuaries and at river mouths, but becomes progressively less important as a river is ascended. Triangulation control established by the cartographic bureaus abounds for estuaries and river mouths, but is, as a rule, conspicuous by its absence along the upper non-navigable reaches. The low order of control used on such reaches is due in many instances to this paucity of geodetic points.

Slopes, or hydraulic gradients, are the most important functions entering into formulas such as Ganguillet and Kutter's, and Manning's, but are probably the most difficult of field determination. Extreme low-water slopes, as determined by ordinary survey methods, are not true gradients and should not be used in such formulas.

Datum planes for levels other than mean sea level, as used on many of our rivers, usually have ample reasons for their existence and are not readily discarded. It may be taken as axiomatic that any datum plane, once it has been formally adopted or otherwise recognized through usage, will always claim recognition, even though it may have been superseded and proclaimed obsolete.

The only practicable datums for soundings in navigable waters are mean low water in tidal reaches, and extreme or ordinary low water in non-tidal reaches. Mean low water is not a true horizontal plane parallel to mean sea level, nor is its position permanent. Wherever channel improvements are planned or in progress, special care is required to determine changes in the position of mean low water.

AERIAL METHODS USEFUL

Aerial photographic methods are peculiarly suited to river surveys because of their flexibility, which permits of adapting them to the many various conditions met with in such surveys. In timbered country, dam sites can be located more satisfactorily by viewing photographs stereoscopically than by inspection on the ground. The letting of contracts for complete aerial surveys, including contouring, is recommended whenever the personnel available for a river survey lacks the experience necessary for the production of maps from aerial photographs.

Much time and money could have been saved in the recent river surveys had the United States been completely mapped by topographic quadrangles on scales not smaller than 1:62,500, and had geodetic control been available along all rivers of importance. The early completion of both map and geodetic control is urgently needed.

There is urgent need for the devising of faster and better methods of surveying and mapping. The present-day laborious ground methods have undergone but little change in the last 30 years. Aerial survey methods appear to hold considerable promise, but still need further development.

The desire has often been expressed that river surveys should be so made as to be available eventually for incorporation into cartographic maps, or for bringing up todate cartographic maps prepared by other Federal bureaus. In the majority of cases, this desire cannot be met, as will be obvious from the preceding discussion. In special cases, where extensive areas must be covered —in the Mississippi Valley for instance), methods can be adopted that will produce maps directly useful for conversion into cartographic maps. Outside of such special cases, however, a river survey should not be regarded as any attempt toward contributing to the cartographic data of the country at large. In the great majority of cases, the river engineer is concerned with securing data for the particular problem assigned to him, and any attempt on his part at general map production would be a misapplication of public funds.

An outstanding feature of the recent Government surveys for river studies has been the effective and wholehearted system of interdepartmental cooperation that has been witnessed. Much valuable assistance has been rendered also by states and cities, and by railroad and power companies.

Aerial Photography for Railroad Location

Field, Office, and Instrumental Methods Described

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AERIAL photography readily adapts itself to reconnaissance and location mapping for railroad and highway routes, and it affords a degree of accuracy equal to, or better than, that obtained by ground surveys for the same purpose. The more difficult and inaccessible the country, the greater becomes the value and the less the comparative cost of the aerial method. In Persia, where Colonel Butler gained his experience with this method of railroad location, it was used on 700 km. out of a total of 1,800 between the Caspian Sea and the Persian Gulf, where 379 km. of railroad construction were completed in the spring of 1930. The Surveying and Mapping Division was fortunate in being able to hear this paper, which was presented at the Norfolk Meeting on April 15, 1931.

THE idea of producing accurate topographic maps from photographs is not new. Over 25 years ago it was used quite successfully in carrying a railway location through some of the more difficult portions of the Yangtze Valley in China. This was accomplished by taking a series of overlapping horizontal photographs from predetermined points of known location and elevation. On account of the large amount of field work required to establish the necessary control system, and the vast amount of computing needed to determine the elevations and locations of a sufficient number of points for the location of contours, the method was of doubtful economy and expediency. The advent of the airplane and aerophotography, the increased knowledge of stereoscopic principles, and the perfection of precision instruments for reducing photographs to accurate topographic maps, have provided railway location engineers with a new and economical means of facilitating and expediting their work. As the greater part of present and future railway construction is in unsurveyed, and often in almost unknown areas of the world, the use of aerial photography is practically indispensable for railway location.

MOSAIC MAPS FOR RECONNAISSANCE

A mosaic map prepared from vertical photographs is a most useful aid in ordinary reconnaissance. In districts where known distances occur at frequent intervals, the photographs may be enlarged or reduced so as to produce a map of uniform scale. Where this is not the case, base lines having termini which can be definitely located in the photographs should be measured at each end of the flight, and at intervening points if the distance covered is long. The local scale of the mosaic is determined from the measured base line and, if the airplane has been held in the same plane throughout its flight, for practical purposes the difference in scale can be distributed throughout the distance.

The elevation of the flight and the camera used should be such that the scale of the resulting mosaic is about 5 in. to the mile. Before the observer goes into the field, the mosaic should be mounted on sheets of such size that they can be conveniently carried; rivers and streams should be brought out in ink; and the location and bearings of the probable route or routes should be indicated. Where the prospective route follows a water grade through a mountainous district, and the location will be confined to a narrow area between the river and the mountain side, a line should be projected on the mosaic showing each tangent with its bearing, and each curve with its radial lines, degree, and central angle.

This line, because of its location relative to the river, trees, rocks, buildings, and other features shown on the photographs, can be easily followed on the ground and is a most valuable aid in determining the character of the best line through the district. If, in making this projection, the sharpest permissible curves are used in turning rock points and bends along the river, it will be possible to determine closely the location and extent of the heavier excavation and embankment, and of the tunnels and retaining walls. This information—supplemented by frequent barometric elevations, the notation of adjustments of the line apparently necessary to make it more closely fit the terrain, the classification of materials, a notation of the side slopes, and a listing of the necessary drainage openings—permits the preparation of a reconnaissance estimate in such detail as to show both the physical characteristics and the cost of the line much more accurately than would otherwise be possible.

Mosaic maps are also very useful in heavily timbered coastal swamp regions and in other places where similar conditions prevail. They show the location of the waterways and thus permit the selection of the probable best route without the difficult ground investigation which would otherwise be necessary.

If aerial photographs are taken at intervals, so that each overlaps its neighbor at least 50 per cent, the overlapping areas, as photographed from the different positions in the air, may be viewed stereoscopically. Since the distance flown between the time of the two photographs corresponds to the distance between the eyes in the ordinary parlor stereoscope, the angle which brings out the relief, or third dimension, is so great that differences in elevation are as apparent as horizontal distances.

Several instruments have been perfected whereby it is possible to construct accurate topographic maps from stereoscopic photographs. Maps so prepared will not only show contours of any desired interval, but also buildings and other man-made structures, and the windings of streams, roads, and trails, with much greater

AN AERIAL MOSAIC MAP OF A SECTION OF THE TRANS-PERSIAN RAILROAD
With a Location Superimposed

accuracy than can be obtained from ground surveys.

During 1928 and 1929, the Syndicate pour Chemins de Fer en Perse, consisting of Ulen and Company and associated American and foreign contractors, used the aerial method on about 700 km. of railway location on the "Lines North" in Persia. As Chief Engineer of the "Lines South" I made a study of the apparatus in the plant of the manufacturers prior to the commencement of the surveys, and also observed the results of this pioneering. The present article is the result.

SPECIAL EQUIPMENT USED

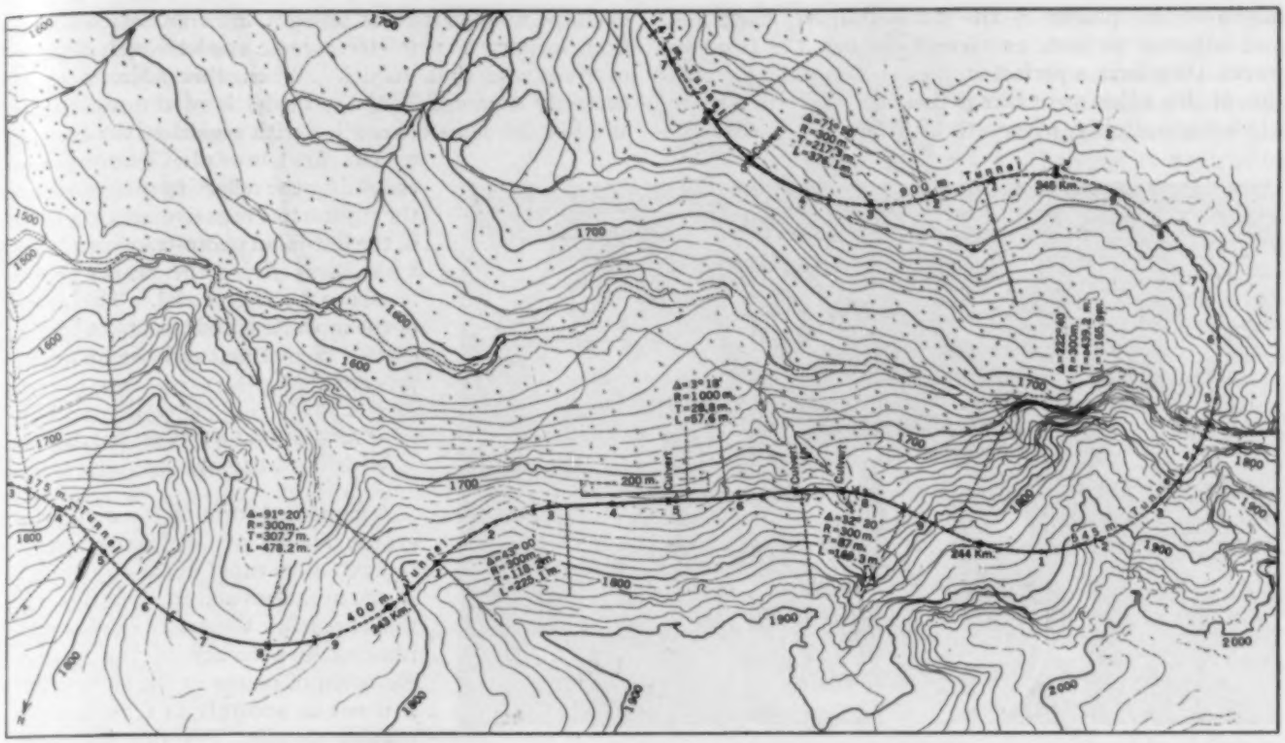
The equipment used consisted of special magazine plate cameras for aerial photography, and the aerocartograph, as perfected by Dr. Reinhard Hugershoff, M. Am. Soc. C.E., and manufactured by the Aerotopograph G. m. b. H., of Dresden, Germany. Recent improvements permit of the use of films instead of plates, thus greatly facilitating the photographic process.

The cameras are either mounted on an outrigger over the side of the airplane or, preferably, in the bottom of the plane so as to take pictures as nearly vertical as possible. They are operated either automatically or by hand. Automatically controlled cameras are connected by a flexible drive shaft to a wind-driven propeller attached to the fuselage. The shaft has an adjustable geared connection so that photographs with the necessary overlap are produced for any height or speed of plane.

The aerocartograph is the trade name of the stereoscopic instrument used in converting the photographs into topographical maps of accurate scale and elevation. The action of the instrument can be explained by assuming a natural-scale relief model of the terrain included in two overlapping photographs, and a pantograph so constructed and mounted that the stylus can only be moved in a fixed horizontal plane. Obviously, if the stylus is brought into contact with the model, it will trace the contour of the elevation of the contact, and if the plane of the pantograph is raised or lowered, other contours will be similarly traced. It also follows that, if a second pantograph is attached to the pencil end of the first, an additional map on a different scale can be made at the same time.

In the aerocartograph, the relief model is replaced by the visual three-dimensional model obtained stereoscopically from the photographs; the stylus is replaced by the so-called "floating arrows" or pointers, corresponding to the intersection of the cross hairs of an ordinary transit; and the pantograph is replaced by a mechanical rectilinear coordinate system controlled by two hand wheels, one of which gives lateral motion and the other departure.

This instrument and its operation were described concisely by C. H. Birdseye, M. Am. Soc. C.E., in the April issue of CIVIL ENGINEERING, page 619. Briefly, it consists of two inverted cameras or photo-transits, symmetrically mounted and connected by a system of prisms and lenses for regulating the path of the light rays and conducting them to the eyepieces; a coordinate system for controlling the optical movement of the float-



THE TOPOGRAPHIC MAP PLOTTED FROM THE AERIAL PHOTOGRAPHS
Produced from Stereoscopic Pairs by Means of the Aerocartograph Instrument

ing arrows or pointers over the face of the photographs and transmitting this movement to the drafting pencil; and a third or vertical movement for changing and controlling the vertical adjustment of the pointers. In tracing contours, this vertical movement is locked and only comes into use when changing to a new contour interval or when tracing streams, roads, trails, or other features of varying elevation.

Photo-transits have lenses of the same specifications as those used in the photographing camera. Provision is made for the proper orientation or centering of the negatives in the photo-transit; for artificially lighting them so that they are plainly visible as viewed in the instrument; for compensating any slight difference in focal length between the lenses of the photo-transit and the photographing camera; and for so adjusting the plates that, as viewed in the instrument, they appear optically in the true horizontal plane.

After passing through the photographic negatives and lenses of the photo-transits, the light rays continue through the telescopes, traversing first the "receiving prisms." The pointers are placed directly behind these prisms, which are so mounted that they may be tilted, thus throwing the line of sight back and forth across the negatives. This movement, which corresponds to the movement in the horizontal axis of an ordinary transit, is controlled by one of the hand wheels of the coordinate system. The other hand wheel is connected with the photo-transits in such a way that the photographic negatives may be moved back and forth at right angles to the line of sight as determined by the receiving prisms, thus permitting the sighting of the instrument on any point in the negatives.

In sighting on any point in the stereoscopic plan, the pointers may appear to be behind the model, in contact with it, or floating in the air above it. By means of the vertical movement, the pointers may be brought into optical contact or coincidence with the point sighted on. If this adjustment is made with only one of the overlapping negatives in view, the pointer will appear to be in the plane which represents the image of the plate or negative as placed in the photo-transit. If made with both negatives in view stereoscopically, the pointer will be in the horizontal plane of the point sighted. If locked in that position, as long as it is moved so as to remain in ocular contact with the ground surface, it will trace the contour of that elevation.

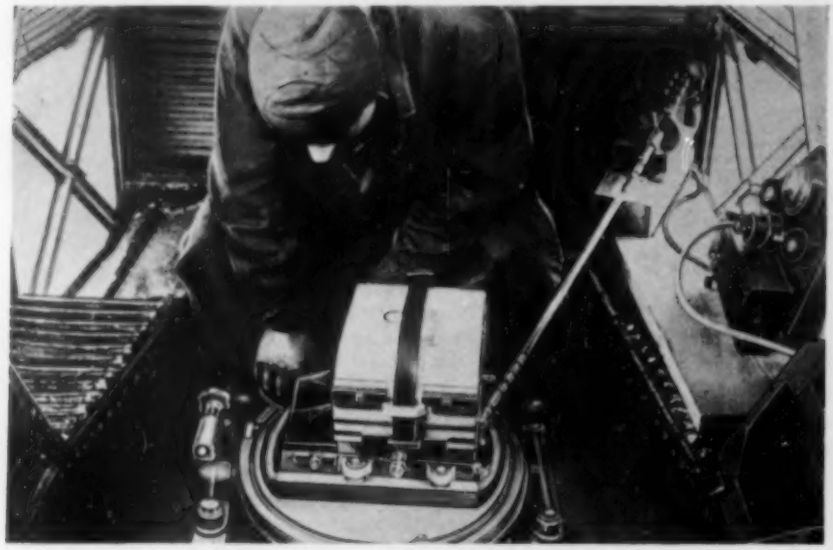
After passing through the receiving prisms, the rays pierce a series of reflecting prisms by means of which they may be crossed, so that the right-hand negative appears to be in the left-hand transit and vice versa. From these prisms the rays travel through a series of lenses, which magnify the image from 2 to $4\frac{1}{2}$ times, and thence to the eyepieces. These eyepieces are adjustable so as to correspond with the horizontal distance between the pupils of the observer's eyes, and they can be focused to bring out the sharpest detail in the negatives.

CONTINUOUS GROUND CONTROL UNNECESSARY

In the first two overlapping photographs must be included a control polygon of three or more sides, the termini of which are of known latitude, departure, and elevation. If surveyed in advance of the photographing, the termini must be so marked that they will be plainly seen in the photographs; otherwise they may consist of points selected in the photographs and surveyed afterward.

A continuous ground control is not required. The two

negatives are placed in the photo-transits, magnified, and adjusted so that, as viewed through the two eyepieces, they form a perfect stereoscopic model. Completion of this adjustment brings them into the same plane, as viewed optically, irrespective of the angle from which they may have been taken. To plat the polygon, the pointers are sighted on each terminal, as viewed stereoscopically, and the scale ratio is calculated.



AERIAL CAMERA IN PLACE IN JUNKER PLANE

By means of adjustable arms in the coordinate system, the ratio is corrected to one directly proportionate to the desired scale of the map, and the gear ratios are changed to give the desired plotting scale. The arm of the third or vertical movement, controlling the adjustment of the pointers is graduated in milimeters, thus permitting the direct application of the scale ratio to that adjustment. To facilitate the adjustment of the pointers and the correct reading of elevations, the arm is equipped with a vernier having an automatic counting device reading to six places.

Following the determination of the scale ratio, the pointers are sighted on, and brought into coincidence with, any three points of the polygon. Both the apparent elevation of these points, and the angle of the plane passing through them, as compared with the horizontal plane, are then calculated. When this angle has been compared with the angle of the same plane as determined from the ground survey, the position of the negatives in the photo-transits is adjusted so as to correct the error. The entire operation is repeated until, as viewed optically, the negatives are in the true horizontal plane and the known points of the polygon plat correctly at the desired scale. The pointers are sighted at, and brought into contact with, one of the polygon points and then raised or lowered the required amount to give the nearest contour interval, thus bringing the instrument into adjustment for platting.

After the area covered by the overlapping portion of the first two negatives is platted, negative number one is replaced by number three, leaving number two locked in the instrument. The portion of number three which overlaps number two is brought into optical coordination, forming a new stereoscopic model which slightly overlaps the first model. When this adjustment is perfectly accomplished, the model is of the same scale and has the same orientation with regard to the horizon as the first model. The rays are crossed by the reflecting prisms so that the right-hand negative appears to be in the left-hand photo-transit and vice versa, thus giving the proper ocular sequence to the model. The plane of the model is tilted to correct for the earth's curvature, and the mapping proceeds.

AEROSIMPLEX GIVES RAPID ADJUSTMENT

A simplified form of the aerocartograph, known as the "aerosimplex," is much more rapid in the adjustment of the negatives and in operation. It makes possible the determination with reasonable accuracy of the relative elevation of points in the survey, but it is not as accurate as regards topographic details. For this reason its use should be confined to reconnaissance and the making of ocular stereoscopic studies of the terrain covered by the survey.

There are several other instruments now in use, some of which are very similar to the one described. Some provide for the determination of the location and elevation of points between which the intervening contours must be sketched; and some do not provide for the crossing of the light rays, so that a continuous ground control is required for the adjustment of the negatives.

By means of the aerocartograph previously described, contours of any desired interval, down to 2 ft., may be platted. For the 2-ft. interval, provided the photographing flight is made as low as practicable, the maximum average error in platting will not exceed one-half of the contour interval, or 1 ft. Due to the grain or surface of the photographic plate or film, greater accuracy cannot be obtained at present. The same maximum error of 1 ft. may be obtained when using larger contour intervals, provided the photographing flight is made at the same height.

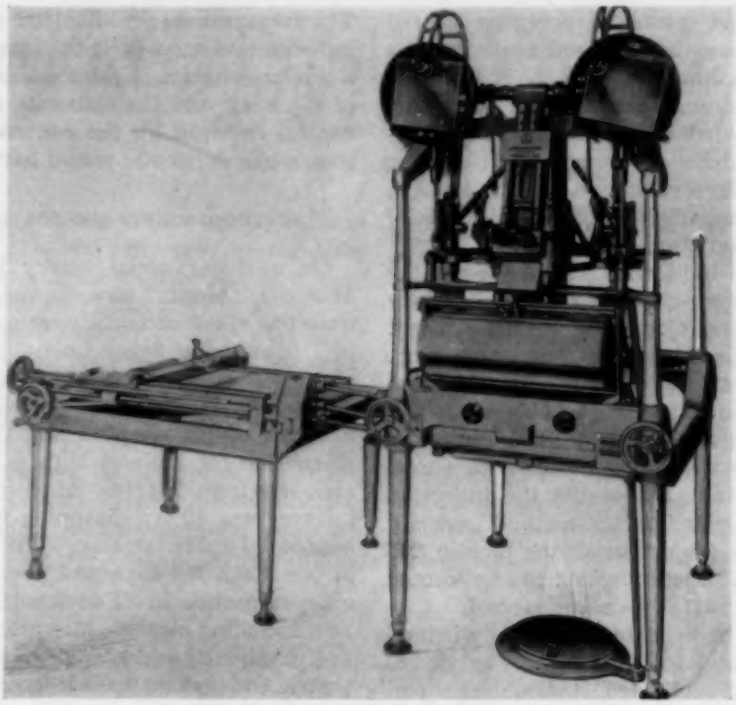
In practice, the photographing flight is usually made at a height which will result in an average maximum error of one-half the contour interval selected. For a map on the scale of 1 in. = 200 ft., with a 5-ft. contour interval, the photographing should be done from a height of about 4,000 ft.

Maps of this degree of accuracy can be made of all portions of the earth's surface, excepting those covered by forests so dense as to practically conceal the ground, or in canyons with sides so precipitous that the lower walls are in continuous shadow. In the latter case, the aerial photographs can in most instances be supplemented by oblique time exposures taken from the canyon rim, which will show all the necessary details. In temperate climates, the portion of the earth's surface which cannot be successfully photographed, even in summer,

is small, and in the winter much smaller. In the tropics, where large areas are covered with a growth so dense as to practically conceal the ground, the aerial method is almost a necessity in making a reconnaissance.

The entire operation, including the photographing and mapping, should be under the constant direction of a locating engineer, who should accompany the photographer during flights and should study each set of negatives stereoscopically as the mapping progresses.

For reconnaissance, the flight should be made at a height of from 10,000 to 12,000 ft. above the terrain. Photographs from this height will permit the platting of 50-ft. contours and will include a sufficient area so that local alternative lines can be mapped and studied. The flight should be extended so as to cover all possible variants and, in case the line crosses a mountain range, it should extend along the divide for a sufficient distance to include all possible passes and tunnel sites.



THE AEROCARTOGRAPH FORMS THE STEREOSCOPIC MODEL
The Coordinatograph, at the Left, Plots the Topography

Ground control other than the original polygon is desirable but not essential. If used, it should consist of a polygon near the center of each flight and intermediate points of known elevation so marked as to be easily identified in the photographs. These polygons will make it possible to check the adjustment of the negatives, thus insuring their continuance in the true horizontal plane as viewed optically. The intermediate bench marks will assist in maintaining the true datum. Neither the polygons nor the bench marks need be connected by a traverse or by triangulation.

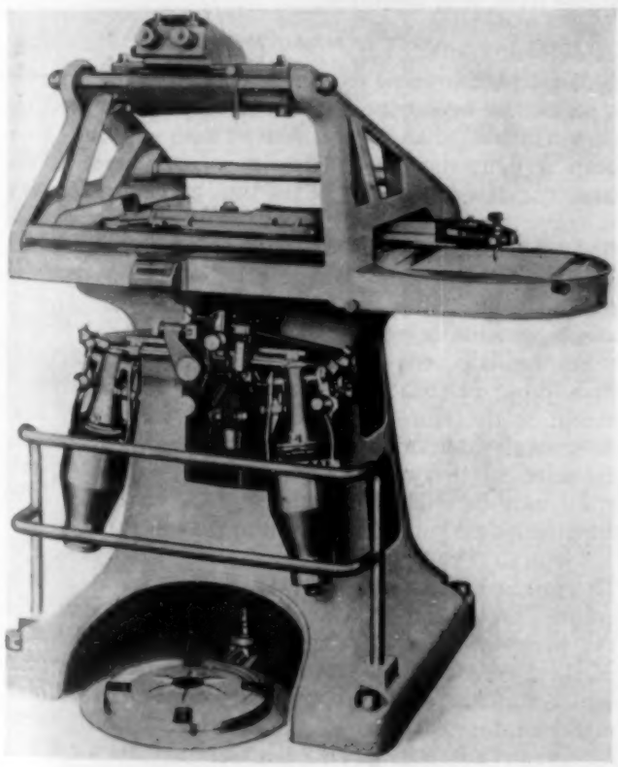
With a ground control of this kind, elevations of summits and controlling points can be determined to within 10 or 15 ft. of the true elevation. Without the intermediate ground control, the relative elevation of points in the same vicinity, as, for instance, mountain passes within a few miles of each other, may be determined with the same degree of accuracy. If the mapping error is cumulative, all local topography will be relatively correct, and even in districts of long supported grade line, the accumulation will be less than 0.05 per cent, and therefore negligible.

Maps should usually be on a scale of 1:10,000, if the metric system is used, and 1:12,000, if feet are used. In addition to contours, it is possible to accurately locate streams, roads, towns, and other features, as well as drainage areas within the limits of the photographs. In undeveloped countries the extent of various types of soil can be seen by the natural growth.

If the reconnaissance is for the determination of the best route to be followed by a location survey, the work may be confined to a stereoscopic study of the route or routes and their indication on the plans. As the various areas of heavier work can be studied in detail and compared as often as desired, and as the comparative drainage requirements are clearly indicated, this route can be determined without supplementing the aerial study by an examination on the ground.

If the report is to be combined with an economic study for the purpose of determining the advisability of adopting a certain construction program, the projected line should be superimposed on a mosaic, and the aerial survey supplemented by a detailed ground reconnaissance, as outlined under the discussion of mosaic plans.

When the scope of the study includes railway location,



THE AEROSIMPLEX, A SIMPLIFIED AEROCARTOGRAPH INSTRUMENT

the ground control should consist of polygons located every 15 or 20 miles along the proposed route, and as many intermediate bench marks as possible. The photographing should be done from a height which will insure contours within the desired degree of accuracy. Ordinarily, mapping should be on a scale of 1:2,000 or 1 in. = 200 ft. In very level country it may be 1:4,000, or 1 in. = 400 ft. A companion mosaic on the scale of 1:10,000 or 1:12,000 should also be prepared.

A stereoscopic study of the terrain should precede the mapping in order to insure a contoured area sufficiently large to permit the proper projection of the line without doing a large amount of unnecessary contour platting. As the mapping progresses, the contour interval should be checked against the intermediate bench marks, and the bench marks—together with a considerable number of other points, such as trees, posts, buildings, roads, and fences along the line to be followed by the projection—should be accurately located on the map. These will aid in superimposing the projection on the mosaic and will serve as a base from which tangents can be located when the final projection is staked on the ground.

The projection should be kept up immediately behind the mapping and compared with the terrain as viewed stereoscopically. As finally adjusted, it should be superimposed on the mosaic and, together with the profile, should be carried in the field ahead of location. Revisions should then be noted, which may be necessary in order to take advantage of better foundation conditions or to avoid insecure ground, the presence of which is not apparent in the photographs.

Because of varying types of terrain and atmosphere, ranging from a monotonous flat or slightly rolling country with a heavy ground haze to mountainous districts of sharp contrast, with deep shadows and a clear atmosphere surcharged with short-wave sun rays, the utmost care must be taken in the selection of the proper film and filter. Care should also be exercised in timing the exposure so that shadows will be penetrated and still have the maximum contrast, the aim being to get a stereoscopic model that will show all the details and stand out in the clearest relief.

APPLICATION TO RAILROAD LOCATION IN PERSIA

The flying time varies with weather conditions and the distance from the base. In Persia, approximately 120 hours were used in studying 400 miles of line. Of this, 18 hours covered passage to and from flying fields; 35 hours were lost because of bad weather; 50 hours were used in reconnaissance; and 17 in photographic flight.

Approximately 1,200 negatives were made, from which 1,000 stereoscopic models were formed and mapped. Maps were on the scale of 1:2,000 or 1:4,000, with 1-m. or 2-m. contour intervals, except in some of the more precipitous places, where 10-m. intervals were used. The contoured area averaged 800 m. in width and took 6,000 hours of actual platting time, or 15 hours per mile for a width of 2,500 ft.

The line traversed the flat areas along the Caspian Sea; the Elburz Mountains, which have a summit approximately 8,000 ft. above the sea (excepting the densely timbered area on the north slope where ground surveys were used); the flat and rolling interior plateau; and the Sultanbulag Mountains between Teheran and Hamadan. The average costs per kilometer were practically the same as for ground surveys on the Lines South, which traversed a similar country. Errors made during the initial period of the work and the elaborate and unnecessary ground control required by the contract greatly increased the cost, which otherwise would have been much less.

METHOD ADAPTABLE FOR HIGHWAY LOCATION

On a recent aerial survey for a highway between Missoula, Mont., and Lewiston, Idaho, 310 miles, including three variants, were successfully photographed in 7 hours total flying time. Two mosaics, one of the scale of 1 in. = 500 ft., and the other on the scale of 1 in. = 1,000 ft., were made of all the lines. In addition, 61 miles of the adopted line through Loxa Pass were platted on the scale of 1 in. = 500 ft. The contoured area was from 1,000 to 2,500 ft. wide, and the contour interval was 10 ft. Mapping was done at the average rate of 1.7 miles per day. The mosaics were completed in less than 30 days and the ground control for the mapped portion in 32 days. The entire cost of the survey, including airplane hire, was approximately $28,000.

If used exclusively, the aerial method is defective in that it conveys no knowledge of high-water elevations, bridge foundation conditions, or insecure ground. However, these objections disappear when the method is combined with a proper ground examination, which should be less expensive than an ordinary reconnaissance through the same district as the exact route is predetermined. In places where the terrain is barren of markings which may be transferred to the map and used as a base from which to lay tangents, the construction engineer will experience the difficulties which are sometimes found in reestablishing a located line after all the stakes have been destroyed.

ADDITIONAL ADVANTAGES

Aerial photographic reconnaissance gives the engineer a permanent ocular proof of the suitability of the routes chosen instead of an opinion derived from what may have been a dangerous and difficult journey through the country. His recollection of the time and effort required to traverse comparatively short defiles may overshadow that of the intervening stretches of easy work, to the detriment of the better route. Also, in making an aerial reconnaissance, it is practically impossible to overlook usable variants or passes.

For location, the contours are much more accurate than those platted from the ordinary ground survey, except in the immediate proximity of the survey line. At a small additional cost, the contoured area may be extended so that the lines of different curvature and grade may be studied in detail and the route definitely adopted before publicity is given to the enterprise.

I wish to acknowledge indebtedness to C. H. Birdseye, M. Am. Soc. C.E., and to H. Gruner, of the Aerotopograph Corporation of America, for their assistance in the preparation of this paper; to Julius Berger, A.-G., of the Berger-Siemens-Holzmann Consortium, German contractors and engineers, in charge of the Lines North in Persia, for the plans of that work; and to the Aerotopograph G. m. b. H. of Dresden, Germany, for a number of the illustrations.

Arbitration in Public Works Contracts

Practical Application of an Ancient Method to Present-Day Use

IN MOST public works contracts, the engineer is named as the final interpreter of the plans and specifications. This practice has been common for many years. It has usually worked out satisfactorily, but differences of opinion between the engineer and the contractor sometimes arise, which lead to complete cessation of the work, pending litigation. Recourse to a court decision is expensive, involves delay, and in the final analysis it cannot be considered as satisfactory to either party to the contract. Legal technicalities and rules of evidence too often take precedence over equity. The two papers on the subject of arbitration which are here published were delivered before the Highway Division at the Norfolk Meeting of the Society, on April 16, 1931. In his article, Mr. Stevens shows the advantages of an arbitration clause in construction contracts, by which the contracting parties agree to submit differences to disinterested and qualified arbitrators. In the light of the experience of the city of Philadelphia, Mr. Beatty gives a detailed discussion of arbitration procedure. The American Arbitration Association, organized by a group of public-spirited men and women, is doing much to promote the adoption of uniform arbitration laws throughout the country.

Advantages to Be Gained

By CHARLES H. STEVENS

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ARBITRATION may be defined as a method of settling differences between parties to a dispute without resort to litigation. The use of arbitration in settling commercial disputes is very ancient and is said to have existed during the days of the Roman Empire. Arbitration flourished in England prior to the seventeenth century, but fell into disfavor in 1609, following the decision of Lord Coke that agreements to arbitrate were revocable. Under this ruling it became possible for one of the parties to an arbitration to withdraw if he saw that he was losing ground. In 1855, however, Lord Coke's decision was reversed, and by 1875 arbitration was restored to a strong position.

The adoption of arbitration in the United States has been very slow because of the lack of authoritative legislation, and it was not until 1920 that the State of New York passed a statute making valid, irrevocable, and enforceable agreements to arbitrate disputes arising out of written contracts. This New York law was followed by similar legislation in Arizona, California, Connecticut, Louisiana, Massachusetts, New Hampshire, New Jersey, Oregon, Pennsylvania, and Rhode Island, and bills have been introduced for the same purpose in the legislatures of Colorado, Montana, Ohio, and Texas.

By the Federal Arbitration Act of 1925, the application of arbitration was extended to interstate commerce, maritime transactions, and matters within the jurisdiction of the Federal courts. More than thirty other states have arbitration laws in one form or another which, however, relate only to the arbitration of existing disputes. The provisions of these laws vary considerably and, in some instances, require compliance with burdensome technicalities.

ADVANTAGES OF ARBITRATION OVER LITIGATION SUMMARIZED

1. Intelligent decisions may be expected from arbitrators who are familiar with the subject matter.

2. The merits of the case alone should determine the decision, whereas court decisions may and often do hinge on technicalities of the law.

3. The presentation of evidence is not likely to be hampered as in court procedure.

4. Publicity and the bad feeling engendered by trials are avoided.

5. Prompt agreements can be arrived at.

6. The cost is generally less and, if so provided, the work may be prosecuted continuously during the arbitration proceedings.

PERMISSION TO APPEAL

Arbitration on public works contracts differs somewhat from ordinary commercial arbitration in that it involves the granting of permission to the contractor to appeal from a decision of the engineer, which would otherwise be final, rather than merely the provision of a method for adjusting disputes in a commercial transaction which has required no more skill, knowledge, or responsibility on the part of one party than of the other. It is probably for this reason that arbitration on public works has not as yet made very substantial progress.

Public officials charged with the administration of contracts for public works, whether they are engineers or men without technical training, are closely hedged about by legislative enactments, governmental or charter requirements, established precedents, public opinion as expressed in the daily press, and, in some cases, by influences of a political nature. Consequently, they are, as a class, reluctant to submit to arbitration the differ-

ences of opinion that arise between themselves and contractors.

Experience has shown how difficult it is to prepare plans and specifications for important public works without conflict between some of the contract provisions. Experience has also definitely established the existence of a class of contractors who invariably seek for such omissions or discrepancies with a view to later submitting ingenious claims as a means of adding to their profits. That arbitration does present certain advantages which engineers, both in public and in private capacities, are beginning to appreciate, is shown by the following facts.

The American Institute of Architects, in its standard form, *The General Conditions of the Contract*, which was issued in 1915, incorporated an article providing for arbitration. This form has been endorsed by the associated building trades and is in general use throughout the country for building contracts.

In December 1921, a joint conference was called by Herbert Hoover, then Secretary of Commerce, to formulate a standard form of contract document for building and construction work. This conference, in March 1924, proposed forms for a *Standard Contract for Engineering Construction* and for *Standard General Conditions for Construction of Buildings*, both of which documents included articles providing for the submission of disputes to arbitration. The conference was attended by representatives of nine leading engineering, architectural, and contracting associations, including:

American Society of Civil Engineers
American Railway Engineering Association
American Association of Highway Officials
American Water Works Association
Federated American Engineering Societies
Western Society of Engineers
American Institute of Architects
Associated General Contractors of America
National Association of Builders' Exchanges.

For several years the American Society of Civil Engineers maintained a special Committee on Arbitration, which was charged with the study of the arbitration laws "passed recently by Congress and by several of the states, to report as to their bearing upon the interests of the members of the Society, and to recommend what action, if any, the Society, its Local Sections, and members should take with reference to these laws or to the movement to secure similar legislation in other states."

SPECIFIC LEGISLATION MAY BE UNNECESSARY

On the recommendation of this committee, the Society has approved a code of rules for the conduct of arbitration proceedings, which were drafted and published by The American Arbitration Association, an organization composed of public-spirited men and women, with headquarters in New York City. The association has also done much to promote the adoption of uniform arbitration laws throughout the United States by the submission to the various state legislatures of a model arbitration act, based on the Federal Arbitration Act.

There are two views as to whether a specific state law is necessary to permit a state or a political subdivision of it to arbitrate disputes. One view is that specific legislation is necessary. In his work, *Commentaries on the Law of Municipal Corporations*, Judge Dillon indicates what appears to be the prevailing view in the following quotation:

"As a general proposition, municipal corporations have, unless specifically restricted, the same powers to liquidate claims and indebtedness that natural persons have; and from that source proceeds power to adjust all disputed claims, and, when the amount is ascertained, to pay the same as any other indebtedness. It would seem to follow therefrom that a municipal corporation, unless disabled by positive law, could submit to arbitration all unsettled claims with the same liability to perform the award as would rest upon a natural person, provided, of course, that such power be exercised by ordinance or resolution of the corporate authorities."

In Pennsylvania, however, the authority to arbitrate disputes arising in contracts for public works cannot be questioned, as an act of assembly, approved April 25, 1927, specifically provides that arbitration may be resorted to upon any written contract to which the Commonwealth of Pennsylvania, or any agency, subdivision, municipal corporation, or political division of it, is a party.

Court records throughout the country indicate that awards rendered in the arbitration of disputes arising out of contracts with states or municipalities have, from time to time, been brought into the courts for the entry of a judgment. This fact is an indication that a number of these disputes have been settled by arbitration. However, there has been very little of such arbitration in Pennsylvania. The State Highway Department contracts, for example, are said to provide for arbitration, but they require that all disputes be referred to the secretary, who is the executive head of the department, and to the attorney-general, a state official.

EXPERIENCE IN PHILADELPHIA

In Philadelphia, a commission composed of prominent business men was appointed by the mayor in 1928, to study and report on the administration of municipal contracts. This commission recommended the standardization of contract requirements and the inclusion in all contracts of a provision for arbitration. The Department of City Transit, whose director is C. E. Myers, M. Am. Soc. C.E., is as yet the only branch of the municipal government that has adopted an arbitration clause. Up to the present time, the department has found it necessary to resort to arbitration only once, although it has awarded 45 contracts for subway construction and equipment, covering a total expenditure of about $30,000,000 under specifications providing for such arbitration.

In the single case which was referred to arbitration, the points at issue involved the propriety of the department's rejection of the contractor's method of procedure and the question of payments under such method. The differences of opinion were largely due to differences in the interpretation of the plans and specifications. The matter was submitted to a board of arbitration consisting of three engineers. This board rendered a decision favorable to the contractor, and its findings have been submitted to the Common Pleas Court and been confirmed by it. Although the decision of the arbitrators was ad-

verse to the city, it provided an interpretation of the specifications which, when confirmed by the court, made it possible for a satisfactory agreement to be reached and for work to be resumed.

ARBITRATION CLAUSE FINDS FAVOR

The Iowa State Highway Department is said to have had marked success with an arbitration clause which has been in use there for a considerable time. According to a recent statement of the chief engineer of the department, only eight cases have been submitted to arbitration in almost as many years. He attributes this small number to the fact that his engineers have been more reasonable in their demands than they would have been if no appeal could be made from their decision.

I am advised that the specifications for the construction of the Lake Champlain Bridge by the states of New York and Vermont contained a provision for the arbitration of matters relating to time and finance. The Detroit Board of Water Supply included a rather detailed arbitration clause in several construction contracts, the total cost of which exceeded $3,000,000. Also, the Port of New York Authority included a limited arbitration clause in its construction contracts, providing in substance that all questions of fact should be determined by arbitration, but permitting the courts to apply the law to the arbitrators' findings.

The practice of declaring the engineer the sole judge of contract plans and specifications is of long standing, and it still prevails in most present-day contracts for public work. The principal justification of this practice lies in the fact that the engineer on such contracts is a public official charged by law with the responsibility of directing the expenditure of large amounts of taxpayers' funds for the general good. Experience seems to indicate that this practice has, in the main, worked out satisfactorily. This is the result not only of the fairness with which the majority of engineers have interpreted their plans and specifications, but also of the spirit of justice prevailing among the majority of contractors, which permits their ready acceptance of the engineers' equitable decisions.

However, conditions are not always harmonious. Serious differences of opinion do arise between contractors and engineers on public works, and at times these disputes lead to a complete cessation of work on the part of the contractor, pending litigation or the working-out of some other method of settlement. Recourse to litigation, with its attendant delays due to congestion of court dockets, its expense, and the necessity of observing arbitrary rules in the presentation of evidence, is generally unsatisfactory to both parties. Cases of this nature require, on the part of judge and jury, a technical knowledge which is rarely found, and a skilled advocate can often misrepresent his client's position in such a plausible manner that a decision is handed down which is favorable to the client but contrary to the merits of the case.

It has been said that the three things essential to a just decision are integrity, intelligence, and a knowledge of the issue, and that, if the last is lacking, a man cannot properly pass on a question, no matter what his integrity or intelligence may be. Decisions rendered by one or more arbitrators having an expert knowledge of the questions involved should prove more satisfactory. In the case of construction contracts, the points most likely to be disputed are the interpretation of plans and specifications, questions of payment, and other matters involving elements of time and money. Arbitration is especially desirable on these questions, as they are usually outside the knowledge of the judge and jury.

Arbitration of questions arising in contracts for public works is often the only method by which the contractor can seek redress, as he is generally unable to sue without the consent of Congress or of the legislature, if the public work is for the Federal or state government. Failure to provide fair means by which contractors can appeal to disinterested, qualified judges for relief from arbitrary decisions on the part of the engineer may result in increased cost of the work or in reluctance on the part of dependable, skilled contractors, to submit bids for public projects.

In conclusion, it is my belief that arbitration furnishes a satisfactory means of adjusting disputes on matters involving the elements of time and money, and on all other questions except those connected with the quality of materials or workmanship, and that its general adoption in public works contracts will place such contract procedure in step with the developments of the times.

How Arbitration Works

Accepted Procedure and Legal Terms Explained

By P. A. BEATTY
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ARBITRATION has been in use from time immemorial. The Romans practiced it at least as early as 450 B.C., and they may have introduced it into England, from which country it came to us. In his *Commercial Arbitration in England*, Mr. Rosenblum mentions it as having been traced from the Hebraic Beth-Din of Biblical times. It was used in this country prior to the Revolution; and during that struggle a court of arbitration of the New York Chamber of Commerce was depended on to settle most of the local disputes which arose. Therefore, arbitration must not be regarded as a mere innovation.

WHAT IS ARBITRATION?

Arbitration is a semi-judicial procedure whereby the contracting parties, instead of resorting to a court of

law for the settlement of a disagreement, set up their own tribunal and select their own judges. Its object is to avoid the formalities, delays, and expenses of litigation, and to submit a dispute to those with a specialized knowledge of the problem.

A provision in any written contract (except one for personal services) to settle by arbitration any controversy that may arise either at the time of the agreement or afterward, is valid, irrevocable, and enforceable in the following states, except on such grounds as may lawfully justify the revocation of any contract: Arizona, California, Connecticut, Louisiana, Massachusetts, New Hampshire, New Jersey, New York, Oregon, Pennsylvania, and Rhode Island. Except in these states, arbitration under a contract to arbitrate is compulsory, but the agreement of the parties to the arbitration contract is not. Consequently, this should not be referred to as compulsory arbitration. Most of the other states have arbitration laws, but as either party can withdraw at will, they are of little value.

Five states—Minnesota, Georgia, Iowa, Kansas, and Arkansas—are said to use arbitration in their highway departments. The cities of Philadelphia and Detroit have arbitration clauses in their contracts, and there may be others which have not come to my attention.

ADVANTAGES TO THE ENGINEER

Engineers are surrendering no portion of their ancient powers by using arbitration, for the method will not be resorted to until the engineer and the contractor have reached a deadlock. Without arbitration, this deadlock must be taken into court. But litigation is expensive and slow; and the courts are clogged with cases. Arbitration, on the other hand, provides an agency quickly invoked, entailing less expense, and producing better and quicker results than those obtained by litigation. The method may also act as a deterrent to deadlocks, as both the engineer and the contractor will want to be sure of their ground before calling in a board of experts to review their actions.

Unrestricted arbitration might be turned into a nuisance by the contractor constantly seeking to start a controversy, or by the unfortunate with an inferiority complex who thinks that everyone is taking advantage of him. To prevent this, the party which invokes arbitration should pay, in addition to the usual costs, a preliminary fee—high enough to discourage the trifler, yet not so high as to prevent the legitimate use of arbitration. Perhaps a sliding scale is needed, a detail not yet worked out.

CHOOSING THE ARBITRATORS

In the selection of arbitrators, the partisan type of person should be avoided. Individuals who find it impossible to dissociate themselves from their preconceptions and preferences sufficiently to make an impartial investigation and arrive at a decision based wholly on evidence; those who attempt to place one of the parties on trial, and convict by bringing in extraneous matters; who become the advocate instead of the judge—such individuals may imperil the success of arbitration by their partisanship. The sole purpose of arbitration is to obtain a full and unbiased record of facts on which the arbitrators can meet in judgment.

With the proper selection of arbitrators, a case in dispute will have more intelligent consideration than is possible in a court of law. Arbitrators with knowledge and understanding of the type of problem to be decided will be better qualified to form just conclusions than the average jury or the average judge.

Without giving the case citations, some of the legal decisions on arbitration may be listed as follows: To make an arbitration agreement irrevocable by statute does not violate constitutional rights. In the construction of arbitration agreements, courts seek to ascertain the intention of the parties as evidenced by the agreements and to give effect to this intention. The decision of the arbitrators, acting within the scope of their authority under a submission agreement, is conclusive on the parties upon matters of law and fact. The submission agreement is the instrument clothing the arbitrators with power to make the award, and they are limited to a decision on the particular matters submitted. The right to trial by jury may be waived and is waived by consent to arbitrate. The award must be as broad as the submission; if it is either more or less broad, it is not binding.

ARBITRATION PROCEDURE OUTLINED

Authorities on arbitration outline a certain definite procedure, which requires and defines the agreement, the submission, the naming of the arbitrators, their oaths and powers, the award and its confirmation; also the collateral steps of stay in the proceedings, remedy for default, motion to vacate, rehearing, modification, declaratory judgment, and jurisdiction.

An agreement to arbitrate may be made a part of any contract, or a clause in any specifications. It becomes operative when the document is signed, but only when the need arises to settle some definite question or questions is a submission made.

A submission is an agreement between the contracting parties to submit to arbitration certain definite matters in dispute, or a dispute in its entirety; and it thus defines the scope of the arbitrators' duties. It must be in writing, and signed by both parties. In some states a submission, in order to be legally binding, must be made a rule of the court.

Where a submission is otherwise legally valid, failure to perform in its making certain acts required by the arbitration law, may cause a court, on application of either party and proof of such failure, to vacate an award. Before arbitration can proceed, any question of validity must be settled by the court, which must be satisfied that there has been a valid submission and that the controversy could have been made the subject of litigation, for the benefits of the arbitration law do not extend beyond the general powers of the court.

There must be at least two parties to the submission, and they must have the requisite legal authority. Only officers authorized to bind a corporation may agree to arbitrate on its behalf. Only when expressly authorized to do so may an agent submit to arbitration on behalf of a principal.

The parties to a submission may include, by reference, the published rules of any organization, if appropriate and legal, which then become a part of the submission contract. The time within which the award is to be

made may be stated in the submission, and an award made after that time will be without legal effect unless it was made upon recommitment by the court to which the case was reported. But the time may be prolonged by mutual consent. If not limited in the submission, the legal limit may be taken at one year.

POWERS OF ARBITRATOR AND UMPIRE

Disputants may agree on one arbitrator; or each may select one, and the two thus chosen may select an umpire. If no provision has been made for the naming of the arbitrators or the umpire, or if there has been a lapse in naming them or in filling a vacancy on the board, the court shall, on application of either disputant, designate such arbitrator or umpire. The death or incapacity of an arbitrator after partial submission voids the arbitration, unless the disputants agree to proceed with the remaining arbitrators or add a new arbitrator to fill the vacancy.

Before undertaking their duties, arbitrators are sworn faithfully to hear and examine and fairly to determine the controversy and to make a true award, to the best of their ability. If the parties proceed to a hearing before unsworn arbitrators without objection, it is considered that they have waived that requirement.

Arbitrators may summon witnesses, requiring them to bring books, records, or documents which may be deemed material evidence. Summonses are served in the same manner as subpoenas. In case of refusal or neglect to obey a summons the court may, on petition, compel attendance or punish for contempt in the manner now provided for securing the attendance of witnesses in the court, or their punishment. Attendance fees are equal to witness fees in courts of general jurisdiction. Arbitrators are authorized to award for the time, expense, and trouble incidental to the appeal, which, if unreasonably taken, is cause for damages. Prior to the commencement of proceedings, the arbitrators' compensation is fixed on a per diem basis by agreement, and may be charged by the arbitrator, together with costs and expenses, against either or both parties.

Testimony may be stenographically taken under oath or affirmation and made a part of the records. On petition, approved by the arbitrators, the court may direct the taking of depositions to be used as evidence before the arbitrators.

The award must be in writing, signed by the arbitrators or a majority of them, and a signed copy must be delivered to each party to the arbitration. Unanimous concurrence is unnecessary unless there are but two arbitrators, when the umpire's decision is conclusive and need not agree with the decision of either arbitrator.

The award deals definitely with all matters of difference in the submission, but the arbitrators may, at their discretion, make a partial award or awards, which are enforceable in the same manner as the final award. A true copy of such award must be delivered to each party without delay. It is not necessary for an award to be clothed in technical language, or for the evidence and each matter considered to be set out to show how the arbitrators reached their conclusions of law and fact. A simple announcement of their investigation and determination is all the law requires.

The county in which subsequent proceedings are to be carried on may be designated in the award unless some court of common pleas has previously entertained a motion with respect to the arbitration. Failing this, the moving party may proceed in the county (1) in which the arbitrators made their report, (2) in which the other party resides or has an office, or (3) in which the court would have had jurisdiction if action had been originally substituted.

At any time within one year after the award is made, any party to the arbitration may apply to the court having jurisdiction for an order confirming the award. The court must then grant such an order, unless the award is vacated, modified, or corrected, as will be prescribed later. Notice in writing must be served on the adverse party or his attorney five days before the hearing. When an order confirming, modifying, or correcting an award is granted, the judgment is entered in the court where the order was granted. A judgment has the same force and effect as judgments in actions at law.

When a suit is brought in spite of an agreement to arbitrate, the court, on application of the party not in default in proceeding with the arbitration, after having satisfied itself that the issue is referable to arbitration, shall stay the proceedings until such arbitration is carried out.

The party aggrieved by the failure, neglect, or refusal of another to arbitrate, may petition the court for an order to show cause why the arbitration shall not proceed as provided, and the court, after investigation, shall order the arbitration to be proceeded with.

OBTAINING FINAL JUDGMENT OF THE COURT

The arbitrators, or the parties to the arbitration with their approval, may apply to the court during the arbitration proceedings for the determination of any legal questions, but this does not operate to stay the

LEGAL TERMS DEFINED

An understanding of the legal terminology applied to arbitration contracts will be aided by the following definitions:

COMMERCIAL ARBITRATION *is the name given to the settlement of a difference, misunderstanding, controversy, or dispute, arising out of property, or professional relations, but not including labor disputes.*

THE DISPUTANTS *should be called the complaining and defending parties, or perhaps complainant and defendant.*

AN ARBITRATION AGREEMENT *is the general term applied to a written contract to arbitrate an existing or future dispute.*

THE SUBMISSION *is an agreement to arbitrate an existing dispute.*

AN ARBITRATOR *is the person to whose determination a matter in dispute is submitted. If there is more than one arbitrator, they constitute a board or committee.*

THE UMPIRE *is the person chosen to decide a controversy whenever the original arbitrators cannot agree. He casts the sole deciding vote, irrespective of the findings of the other arbitrators, unless the law or the submission provides otherwise.*

ARBITRATION TRIBUNAL *is the place where the hearings are held.*

AN AWARD *is the written document embodying the decision.*

ARBITRATION LAWS *refer to the United States Arbitration Act (Vol. 43, 68th Congress, 1923–1925, Ch. 213, Sec. 1–15) or statutes prevailing in the jurisdiction where the arbitration takes place.*

ARBITRATION RULES *are those agreed upon or consented to by the parties.*

GENERAL AND SPECIAL RULES *are (1) those generally applicable or in common use and (2) those adopted by the parties to the dispute, or to meet a situation not covered by general rules.*

proceedings unless with the consent of the arbitrators.

An order to vacate an award may be made if there is evidence (1) that the arbitrators were guilty of corruption, fraud, partiality, or undue means; (2) that they were guilty of misconduct in refusing to postpone the hearing when sufficient cause was shown, or in refusing to hear pertinent and material evidence, or of any other misbehavior prejudicial to the rights of any party; or (3) that the arbitrators have exceeded their power or so imperfectly executed their duties that a final award on the matter submitted was not made. When an award is vacated prior to the expiration of the submission limit, the court may direct a rehearing of the arbitration.

The court may modify or correct the award or resubmit the matter to the arbitrators on application of a party to the arbitration: (1) on evidence of any material miscalculation of figures, or of a material mistake in a person or thing described; (2) if an award was made on a matter not submitted, unless it affected the merits of the decision on the matter submitted; or (3) where the award is contrary to law and such that, had it been a jury verdict, the court would have disregarded it. Applications to set aside, modify, or remit an award must be made before the entry on the final judgment on the award; except that courts of chancery cannot be deprived of their jurisdiction.

With the motion to vacate, modify, or correct an award there should be filed with the prothonotary (1) the agreement, the selection or appointment of an additional arbitrator or umpire, and each written extension of the time within which the award is to be made; (2) the testimony, if stenographically taken; (3) the award; and (4) each notice, affidavit, or other paper used in connection with an application to confirm, modify, or correct the award, and a copy of each order of the court in regard to such an application.

When an order confirming, modifying, or correcting an award has been granted, judgment is to be entered in conformity with it in the court where the order was granted.

THE LAWYER'S REACTION

It might be supposed that the legal profession would oppose arbitration on the ground that it would have a tendency to diminish its business. In the *Journal of the American Judicature Society*, for February 1929, Carl E. Herring wrote:

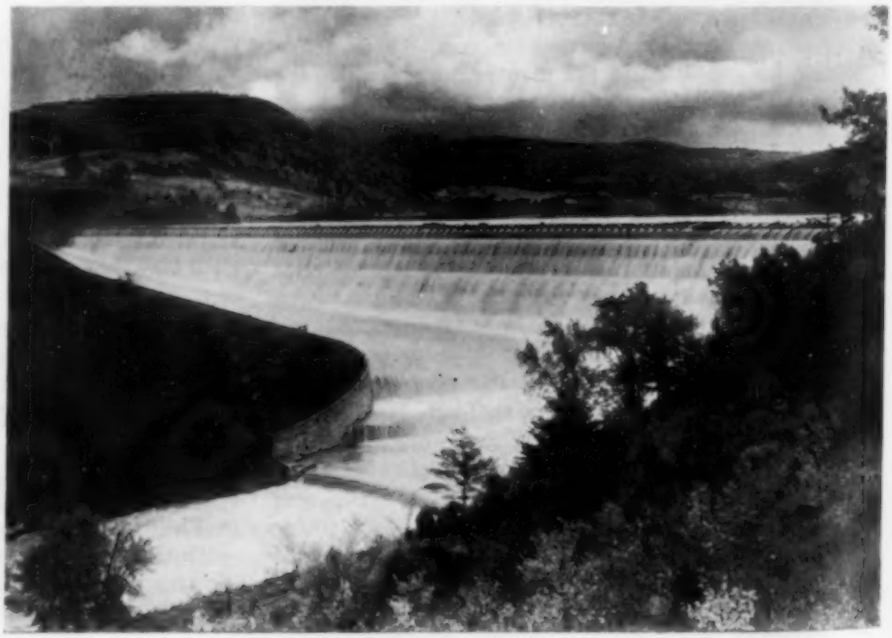
"Will the future practitioners of arbitration be mainly lawyers? It begins to seem so, for in our greatest commercial city, it is the lawyers who are diverting commercial disputes to arbitration tribunals." This is explained by the statement that this practice "seems to be of as much benefit to the lawyer as to his clients. . . . a lawyer . . . . knows what a dispute costs and of what vital importance to business egterprise are delayed settlements of such disputes. Small wonder, then, that in the best interests of their clients, lawyers are seeking ways to avoid the long delays in court, to cut the cost of the disputes, and to minimize the importance of business differences in commercial arbitration."

He states further that, throughout the country, over 1,200 lawyers have enrolled to constitute a special panel of arbitrators, each ready to serve as required, with no compensation, in order to encourage this form of adjudication; while the American Arbitration Association has established 1,700 tribunals in as many cities, consisting of 7,000 bankers, lawyers, and business men, representing virtually all lines of industry. In 1929 this organization introduced a uniform arbitration bill in the legislatures of 37 states. This was made possible by the cooperation of lawyers, who believe in and practice arbitration.

A WATER SHORTAGE RELIEVED

A threatened water shortage in the Catskill and Croton systems for the New York water supply, is now happily averted. The photograph shows discharge over the spillway of the Gilboa Dam of the Schoharie Reservoir. This is the most distant and northerly of the Catskill group and holds about 19½ billion gallons. Its natural flow is toward the north into the Mohawk Valley, but 1,000 sec-ft. is diverted south through the 18-mile Shandaken Tunnel to the Ashokan Reservoir.

On May 14 the Ashokan Reservoir was 65 per cent full; Kensico Reservoir, 95 per cent full; and Croton Lake lacked 5.7 ft. of overflowing. Rains on the upper watersheds for eight consecutive days prior to May 15, 1931, will continue to yield still further beneficial results in obviating danger for the coming seasons.



Norfolk's First Essentials for Sanitation

Sewerage and Water Supply

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DEFINITE steps toward the development of Norfolk's present water works were first taken early in the seventies. Ten years later, due to the high ground-water level, a sewage disposal system by pumping to the ocean was found imperative. An 1,800-ft. siphon built in Brewer Street in 1885 is still giving service.

Following the drought of 1919, the $4,000,000 Lake Prince water supply system was developed. By fully metering the service, the use of water has been kept down to 12 million gallons per day. If the unrestricted use of water had continued, Mr. Taylor estimates that the present demand would be 32 m.g.d. Meters have not only saved Norfolk the costly development of additional water supply but also the expense of completely remodeling the sewerage system. This paper was presented by Mr. Taylor on April 16, 1931, before the Sanitary Division at the Norfolk Meeting of the Society. In the discussion which followed, Mr. Chester described the installation and acquisition of a privately owned water company and the enlargement of the pumping station to increase its capacity to 15 m.g.d.

NORFOLK'S first municipal water supply was a spring near Cove and Cumberland streets, to which a public way was opened from the main street of the town. Afterward the "town pumps," six in number, located at street corners over wells or cisterns, together with private wells, did service for generations—in fact, for 190 years after the birth of the town, until the population was nearly 20,000. Then, in 1871, the purchase of two small ponds five miles east of the city, with 4 sq. miles of watershed, provided the nucleus from which the modern plant has been developed. A pumping station with pumps of 2 m.g.d. (million gallons per day) capacity, was then erected, and connected by a cast-iron main 12 in. in diameter, to a distribution system composed of 13 miles of pipe. This beginning, ambitious and creditable in comparison with all previous efforts, was soon found inadequate because of the small watershed and storage capacity of the ponds.

Ten years later, the installation of a system of sewers was begun. Engineering principles then untried were used in this construction and, in the subsequent operation of the sewerage and water works, some unusual problems were encountered.

The year previous to the establishment of the municipal water works in Princess Anne County, when cisterns and surface wells furnished the supply, the Board of Health in its annual report stated with pride that the "general health of our City, equal to that of any seaport city, is the occasion for much satisfaction." In the same report, however, the death rate from typhoid fever, malarial fever, dysentery, and diarrhea—diseases which largely reflect conditions of sanitation and water supply—was set forth as 100, or a rate of 5 per 1,000 population. This, compared with the 1930 death rate from similar causes of 0.33 per 1,000, speaks badly for the old order of things.

SEWERS INSTALLED IN 1881 SERVED DUAL PURPOSE

Construction of sewers throughout the old city was commenced in 1881 and completed soon after; and each following year has witnessed an extension of the system. Not only did those first sewers provide for the sanitary disposal of sewage from all premises connected with them, but they also proved beneficial by lowering the water table throughout the entire area served—another great aid to health. Local soil conditions were such that these results were far reaching. The maintenance of street pavements, which had been previously accomplished with difficulty, was much simplified. Cellars were dried up, as were also large surface areas which had been swampy except in the driest seasons. Many ideal propagating beds for mosquitoes were thus eradicated.

Another favorable result was the draining of the large burying ground, now almost centrally located geographically. Burials below ground had previously been impossible in the winter, and vaults were resorted to. By the installation of a small system of tiling connected with the sewer, the area was so completely dried up that thereafter no water was encountered at any reasonable depth at any season of the year.

PUMPING REQUIRED FOR SEWAGE DISPOSAL

Since the elevation of the streets above mean sea level is slight, it is impossible to keep the sewers above tide for gravity discharge. Pumps were therefore necessary and were included in the design, to elevate the sewage from wells and to send it on to tidewater to be disposed of by dilution. The pumping stations, 20 in number and all but two automatically operated, have been located in the lowest available areas. From them radiate lines of terra cotta and cement pipe, laid with flat grades at depths varying from 5 to 18 ft.

Calculations to determine the size of the sewers were based on Kutter's formula and the values of C as determined by the experiments with the Sudbury River conduit near Boston, assuming that 100 gal. per capita reached the sewer in 12 hours, and that the pipes were half full. As a rule, the topography of the land fixed or limited the hydraulic slope.

Grades as flat as 0.1 per cent for pipes only 10 and 12 in. in diameter have given no trouble in 30 years. The plumbing laws, which require 4-in. vents, or larger, to all

premises, insure good circulation of air and freedom from sewer gases where and when velocities are slow.

The trunk sewer was designed to be 17 ft. below the surface of Brewer Street, which is only 40 ft. wide. Danger of undermining the high brick walls of buildings abutting on the street, because of the very treacherous nature of the soil, led the engineer in charge of construction, W. T. Brooke, to design a true but elongated siphon in lieu of a deep gravity line.

NORTH SHORE POINT, A RESIDENTIAL SECTION OF NORFOLK
The High Ground-Water Level Is Apparent

This siphon, of cast-iron pipe 14 in. in diameter, opens at each end into wells at the same level, about 25 ft. below the surface of the ground. The intake is 1,800 ft. distant from the outlet, and throughout this distance the pipe was laid about 3 ft. below the street. The outlet was kept 8 in. below the pump section in the well, and turned upward with a weighted check valve. This arrangement prevents air from entering either end of the siphon when the flow slows down because of a diminishing difference in the level of the water in the two wells, and insures successful operation as long as the vacuum is maintained. At the apex, a small chamber was built and connected by a 2-in. pipe with a vacuum pump in the station 1,200 ft. away.

In his report of 1884, the designer wrote: "Of the successful working of the siphon I have not the slightest doubt, and I am of the opinion that its adoption has solved a very difficult problem so far as the completion of Section B is concerned." He lived to see his prophecy fulfilled. This siphon, placed in service in 1885, was, I believe, the first extensive use of this principle in sewage works. It has functioned as intended without interruption, except for the making of a few minor repairs.

These repairs comprised the replacement of certain lengths of the 14-in. cast-iron pipe, in which the inverts had been worn away by the sand particles carried along with the sewage. In some places, more than a half inch of good cast iron had been in this manner cut away by attrition and carried out to sea, thus making holes in the pipe and breaking the vacuum.

UNINTERRUPTED SERVICE

From the lower well into which this siphon, as well as the sewers serving a large section of the old city, empties, steam-driven pumps have raised the sewage and discharged it into the river without an hour's interruption since the early eighties. The invert of the discharge line from this station has likewise been worn away by attrition. About 12 years ago it began leaking in spots throughout 800 ft. of its length under the street pavement. By clamping sheet metal, curved to the radius of the pipe, with a gum packing over each hole, the entire pipe was encased with 4 in. of reinforced concrete without interruption of service.

Recently, for reasons of economy or efficiency of operation, the pumping station on City Hall Avenue has been electrified. The original pumps there were of the reciprocating type, but they were soon replaced by centrifugal pumps directly connected with steam engines. These last mentioned units have proved absolutely reliable and, indeed, they were designed for dependability rather than for efficiency, for there can be no interruption of service. The electrification of this station came only after the perfection of certain electrical apparatus having dual underground supply circuits, and the improvement in gasoline motors for quick relief. The saving from this change has been a little over $1,000 per month during the past three years.

Because of the oyster interests, there has been some criticism of the method of disposal, and the subject of a treatment plant has been discussed. Granting the wisdom of all such measures generally, the oyster interest

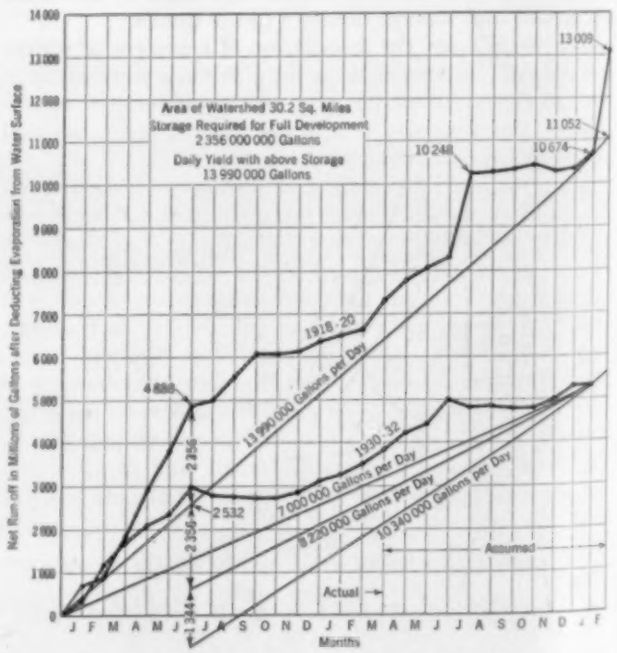


FIG. 1. MASS CURVE FOR LAKE PRINCE SUPPLY

responsible for the agitation is not likely to profit by the compulsory installation of treatment plants for cities bordering on Hampton Roads, because there is pollution from many other sources impossible of correction. So great is the volume of water passing Hampton Roads twice daily that, in so far as Norfolk is concerned, a treatment plant will not become a practical need for many years to come. Although a large increase in population in the lower part of the city, due mostly to tall buildings, has resulted in a large increase in sewage, the systemas originally designed and built is still functioning well.

SPILLWAY OF THE LAKE PRINCE DAM
Capacity 220 Sec-Ft. per Sq. Mile

Built in 1872, the water works have of course been enlarged from time to time, and the watershed and storage reservoirs have been extended four times. After a well had been driven to a depth of 1,800 ft. without finding water, all ideas of securing a supply from underground were abandoned. In the year 1900, rapid sand filters were installed. In 1908, with 9,000 unmetered taps, the daily consumption reached 9 m.g.d., overtaxing all facilities connected with the plant. The introduction of meters on all services reduced this consumption to an amount little in excess of 5 m.g.d., and thereafter no real trouble developed until 1919. When the United States entered the World War the daily pumpage averaged a little more than 6 m.g.d. Engineers of national reputation, called in consultation, computed that the city's supply in dry years was safe only for 7 m.g.d.

A NEAR CRISIS

When, in 1919, the reservoirs were pumped low, the storage in the surrounding sandy soil proved far in excess of expectations. However, a draft of $13^1/_2$ m.g.d. during the last year of the war and the year following, so depleted the supply that, in December 1919, preparations were made by the water department to pump salt water into the system for fire protection and sanitation. Steps had also been taken to supply the population of 120,000 people with drinking water at various street corners from tank cars, motor sprinklers, and wagons, the water to be obtained from the neighboring city of Portsmouth. A providential rain early in January 1920 came only a few days in advance of such drastic action.

LAKE PRINCE SUPPLY DEVELOPED

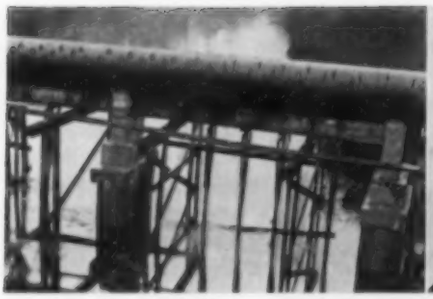
Confused by conflicting opinions and political influence, the city council had deferred enlargement of the plant for 15 years prior to the beginning of the war. The unprecedented drought and the near calamity to which allusion has just been made proved the correctness of the water department's warnings and the wisdom of its recommendations for an increase in the supply. This finally resulted in action by the citizens, who gave to the council and, in turn, to the city manager, the authority to provide an additional supply, making available $6,000,000 for that purpose. However, prior to this election and authorization, the wartime demand made imperative the enlargement of the old works. This undertaking is described by J. N. Chester, M. Am. Soc. C.E.

The new works, built as a result of the $6,000,000 bond issue, are known as the Lake Prince Supply, and lie in the opposite direction from the old works, being almost due west of the city. This location proved necessary because, with the exception of the present source of supply and the Lynnhaven River, unavailable because of oyster interests, there is not in all the alluvial plane surrounding Norfolk a water course with riparian lands sufficiently elevated so that water can be impounded deep enough to prevent the loss of most of it by evaporation during dry years, such as 1919 or 1930. It was necessary to go westward 20 miles, about 40 miles from the sea, to find a valley in which it would be possible to impound water to a depth of 30 ft. The site chosen was in Nansemond County, near Exit, and the reservoir was begun late in 1920.

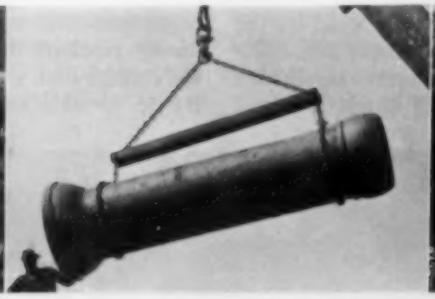
With a consumption of 13 m.g.d. and peak loads reaching a rate of 18 m.g.d., in addition to the service required by the fire underwriters for a city of this size, a new daily supply of from 12 to 15 million gallons was determined upon, with, of course, possibilities for further extensions.

At that time, the water supply of Portsmouth was privately operated, and the company owned practically all of the available and desirable water sources to the westward. Joint ownership and unification of the two water systems was proposed, but abandoned when studies disclosed the fact that Norfolk could obtain a new supply at less cost by proceeding independently. Negotiations resulted in the purchase by the City of Norfolk, a year prior to the great drought, of two of the four waterways mentioned.

In order to determine the yield of the watershed selected, mass curves were prepared, and the records of the department as to available net run-off were applied, after allowing for evaporation. Computed on the basis of the rainfall from January 1918 to January 1, 1920, a period covering the two driest years on record prior to 1930, the full development of Lake Prince required a storage of 2.4 billion gallons. Thus developed, its safe yield would be 14 m.g.d., or 470,000 gal. per sq. mile of watershed, the amount set as a minimum for the new works.



36-IN. WOOD-STAVE PIPE LINE
Good After Ten Years of Service



FLEXIBLE JOINT, 30-IN. CAST-IRON PIPE
Elizabeth River Crossing

CONCRETE PRESSURE PIPE
36 In. in Diameter

On the mass curve made in 1920 to show the estimated yield of this watershed, I have recently plotted the run-off from the abnormally low rainfall of 1930, and assumed a similar year of low run-off for 1931. Should such a drought occur, it appears that the "estimates of safe yield" would need to be materially revised.

In a northwesterly direction and immediately adjacent to the watershed utilized by the city in this development, there lies a watershed of 25.4 sq. miles, permitting developments almost identical with those undertaken, except that the possible storage is not so great. By constructing a dam 30 ft. high, and one mile of tunnel through the divide, in marl, the two water sources can be united—made in reality one. This additional development will yield not less than 12 m.g.d. In addition, in a westerly direction, not more than 7 miles distant from the headwaters of the present development, the waters of the Blackwater and Nottaway Rivers are available. The watershed tributary to these streams totals 2,600 sq. miles. It is thus seen that, in the immediate vicinity of the new reservoir, enough water to meet the requirements of a large city can be had.

EARTH-FILL DAM BUILT IN 1920

The site chosen for the dam is such that a storage of four billion gallons, about 12,000 acre-ft., is obtained, and it is practicable to increase this storage. In the general plan for future development, this excess storage has much worth. Moreover, the excess would carry water in storage over into such dry years as may occur, thus adding to the daily estimated yield.

Borings at the site of this dam, under its highest portion, showed from 10 to 20 ft. of swamp muck, then from 2 to 15 ft. of sand, and finally, a thick stratum of hard stiff marl, impervious to water, and capable to a remarkable degree of resisting its erosive action.

To insure a stable fill, the entire thickness of muck was removed. Along the upstream toe of the earth dam, interlocking steel sheet piling was driven to marl and capped with concrete, which was carried to the top of the dam as a water cut-off to prevent seepage. The dam, which contains 90,000 cu. yd. of selected material, is 50 ft. high from foundation to top. In ten years it has shown practically no settlement.

Below the dam, a stone, brick, and concrete building houses electrically driven pumping machinery. A transmission line four miles long connects with the electrical lines of the Virginia Electric and Power Company, connecting Norfolk and Richmond, and furnishes the required power. In case of line trouble or interruption of the power, a modern gasoline engine is kept ready for service. Centrifugal pumps of several sizes, ranging from 3- to 15-m.g.d. capacity, deliver raw water as it is needed to the filtration plant within the city through a conduit generally 36 in. in diameter. This pipe line from the dam to the city, partly 30 in. and partly 36 in. in diameter, is $18^1/_2$ miles long, and was designed and built to deliver raw water into the city at the rate of 16 m.g.d. In its construction, four navigable rivers had to be crossed with channels from 20 to 60 ft. deep.

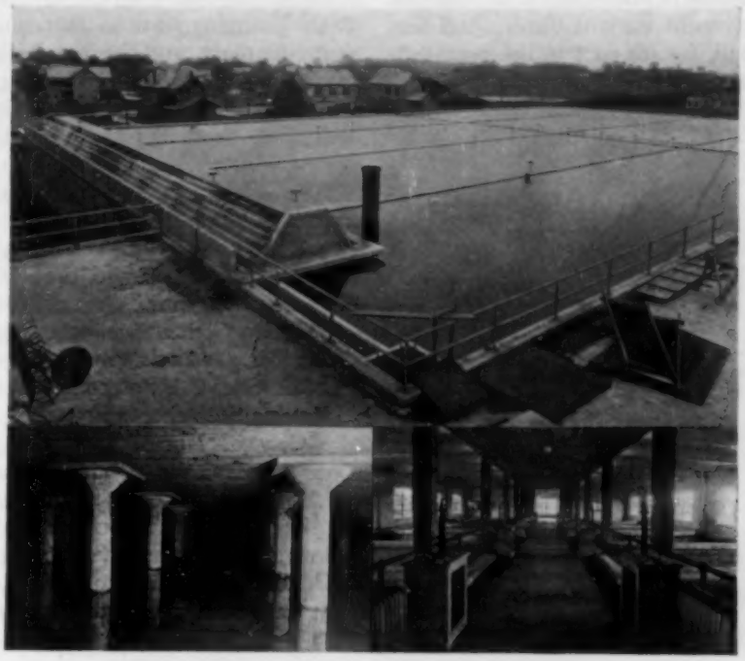
Influential citizens strongly protested against the use of anything but cast-iron pipe throughout. A careful study of the route of the line and of comparative figures bearing on the financial outlay, carrying capacity, leakage, and durability of different types of piping, which was submitted to the City Council by Dabney H. Maury, M. Am. Soc. C.E., resulted in the use of wood-stave pipe, concrete pipe, and standard cast-iron pipe. For reasons of economy, wood-stave pipe was used wherever local conditions favored its durability. Cast-iron pipe was installed where conditions were not conducive to the durability of wood, and where it was not practicable to use concrete pipe, as then made.

It was estimated that the wooden portion need only last ten years to warrant its use from the standpoint of economy. It has passed its tenth birthday, requiring practically no attention or maintenance in the meantime, and should last many years more. Wherever visible, it appears to be in good condition.

With accurate means of measuring the flow of water through this line and the loss of head, determined by mercury columns, calculations were made in 1924, using the Hazen and Williams formula for the value of C in the different wood and concrete sections of the pipe, which vary in length from 4,700 to 39,000 ft. These tests, made shortly after the line had been put in service, indicated a value of C for both wood and concrete of between 138 and 142, and averaging 139.

Within the past few days new tests have been made in the same way as the previous ones, and after six years of use, it is found that the value of C in the line as a whole has decreased. For instance, the pressure required to pump with a certain pump rated at 13 m.g.d. in 1924 developed a pressure of 55 lb. at the station. In the past few days this same pump, delivering $12^1/_2$ m.g.d., developed a pressure of 72 lb. In a concrete section 11,000 ft. long, C has decreased from a value of 140 in 1924 to 137 in 1931. In the 40,000-ft. wooden section tested, C has decreased from 138 to 131; and in the cast-iron sections of the line it has also fallen rapidly.

In the submerged line across the Elizabeth River, a cast-iron pipe 30 in. in diameter has behaved in an astonishing manner. This pipe was manufactured with great care. The "barrel" was given a thickness of $1^5/_8$ in. and wide steel bands were shrunk around the large bell at the end, which was designed and built for a flexible joint. It was laid with skill and care in a soft bed. However, within a year after, while the leakage in the line was being measured by volumetric displacement, and before the station was placed in service, the first of 11 cracks appeared. It can be positively stated that the crack did not result from a blow such as would be caused by the dropping of the anchor from a large ship, nor were any of the other cracks due to a similar act of violence.



THE FILTRATION PLANT OF THE CITY OF NORFOLK
Above, Aerator and Coagulating Basins
Left, Storage for Filtered Water Under Coagulating Basins
Right, Operating Floor of Filtration Plant, Wash-Water Tank Overhead

Soon after the first crack appeared, in August 1922, others, each in the middle third of the pipe section, developed—one in 1925, three in 1926, two in 1928, and four in 1930. The average area of each opening has been about 2 sq. in., and the average leakage at the rate of $1^1/_2$ m.g.d. The cracks were quite similar in general characteristics, and not confined to any one location.

No satisfactory explanation has been made as to why the metal should act in this manner after ten years. Not yet has any crack extended beyond the middle third, or entirely around the pipe. Divers made the repairs by means of split sleeves with precast lead joints, ready for the air hammer. Of course, the tedious part of the procedure is the location of the leak and the removal of the superimposed earth. The total cost of making all the 11 cracks tight again was $26,000. How is this pipe likely to stand up in the future? We are much concerned about it.

MODERN FILTRATION PLANT AND PUMPING STATION BUILT

At the end of the raw water line within the city, a modern filtration plant and pumping station has been built, with an aerator, coagulating basin, filters, clear water reservoir, and pumping equipment, ready for the treatment and delivery of 12 m.g.d. of good potable water into the distribution system. The plant was designed for a normal capacity of 24 m.g.d., only one-half of which is necessary at this time.

For the introduction of alum into the raw water line, hydraulic ejectors are used in preference to an elevated chemical house. For wash water, either a motor-driven centrifugal pump, or water from a storage tank is available. The tank is a concrete box 14 by 100 by 4 ft., built under the roof of the filter building. By this means a uniform head is obtained for the washing of filters, and the unsightliness of an elevated structure is eliminated. A cross-compound steam pump of 12-m.g.d. capacity delivers the water into the distribution system, and two 6-m.g.d. electrical units are kept ready to supplement the steam unit or to take the load should the pump need repairs.

COSTS AND SINKING FUND

The operating cost of delivering water from Lake Prince to the city averages less than one cent per 1,000 gal. For filtering and pumping into the distribution system, an additional two cents per 1,000 gal. is the average cost, exclusive of interest and depreciation.

In the system today there are 32,000 active taps. Last year the pumpage amounted to 4.7 billion gallons, or 13 m.g.d. Had meters not been in general use since 1908, the pumpage at this time would be 32 m.g.d. rather than 13 m.g.d., estimating on a comparative basis. This would mean not only extensive additional outlays in the water department, but likewise a complete remodeling of the sewerage system in the old part of the city.

The city maintains a laboratory with a full-time chemist and assistant. Occasionally algae in the Lake Prince water give trouble, but by the use of sulfate of copper in the reservoir, and prechlorination, the taste from this source has been controlled. By the use of aeration, alum, and filtration, an acceptable and reasonably soft water is produced at both plants. Excess carbon dioxide is neutralized by the addition of a little lime.

Bonds issued by the City of Norfolk for water supply purposes to date total a little over $9,000,000. Of these bonds, $3,000,000 represent the outlay for the old works and a part of the distribution system; $4,000,000 for the new supply; and $2,000,000 for the purchase of two competing water companies and the remodeling of the distribution system.

Our annual income from water at this time amounts to nearly $900,000, of which $244,000 was required last year for operation, and the balance for interest payments and sinking fund obligations. This sinking fund today amounts to more than $2,000,000; it is expected to retire

one-third of all water bonds now outstanding in 1942, and the remaining two thirds in 1950.

I wish to acknowledge my indebtedness to professional men such as J. N. Chester, Dabney H. Maury, and the late Allen Hazen, all Members Am. Soc. C.E., for the benefit of their advice given at various times; and also to my assistant, N. Z. Ball, for his part in the establishment of Norfolk's present supply.

Developing the Water Supply

By J. N. CHESTER

MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
CONSULTING ENGINEER, PITTSBURGH

BY purchase of the property of the Portsmouth, Berkeley, and Suffolk Water Company, the American Water Works and Guarantee Company, of which I was Chief Engineer, came into possession in 1905 of the water works supplying the city of Portsmouth. The plant at that time obtained its water supply from Lake Kilby, near, Suffolk. The water, unfiltered, was delivered through a 20-in. cast-iron main some 20 miles to a receiving basin in the City of Portsmouth and there repumped by direct service into the mains of the Portsmouth plant.

WATER WORKS OF THE CITY OF NORFOLK

The Original Pumping Plant

Among the first activities of the American Water Works and Guarantee Company after the purchase was the installation of additional pumping machinery at Suffolk Station, the construction of a filtration plant adjacent to the pumping station, the rebuilding of the Portsmouth pumping plant, and the installation of additional machinery there, followed later by a provision to supplement the Lake Kilby supply by building a pumping station on Lake Cahoon and a pipe line for the delivery, in dry times, of water into Lake Kilby.

By the acquisition of the Portsmouth, Berkeley, and Suffolk Water Plant, four major water supplies were acquired; those of Lake Kilby, Lake Cahoon, Bensten Lake, and Phillips Lake, the last two of which were subsequently sold to the City of Norfolk to become the basis of the new South Side water supply project carried out under Mr. Taylor's direction, with Dabney H. Maury, M. Am. Soc. C.E., as consultant.

Having been chosen in March 1918 to jointly represent the City of Norfolk and the Norfolk County Water Company in the proposed purchase of these water works for the City of Norfolk, I was privileged to outline the benefits that the city might gain by unifying these plants and acquiring the distribution mains.

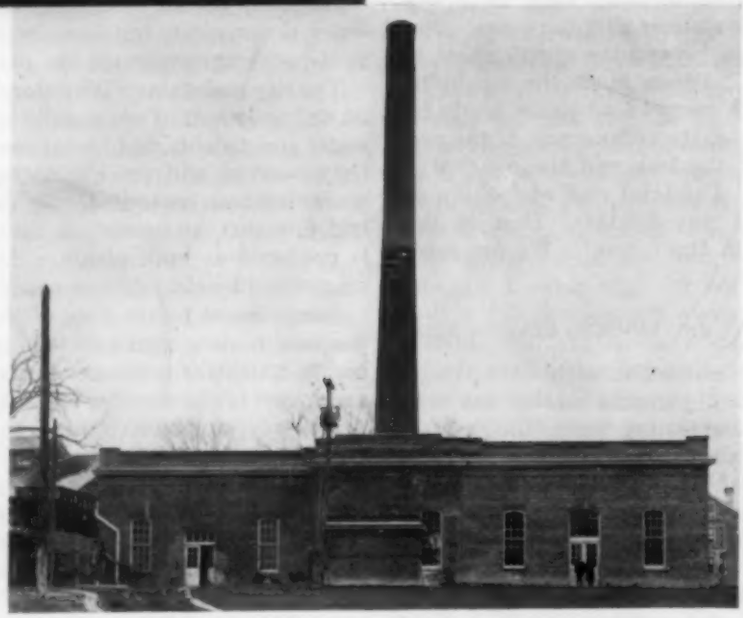
Conditions relative to storage and water supply for the city and county of Norfolk may be shown as follows:

PLANTS	CATCHMENT AREA IN SQ. MILES	STORAGE IN GAL.	STORAGE PER SQ. MILE OF CATCHMENT AREA
Norfolk City	18.6	2,580,000,000	138,000,000
Norfolk County	12.15	440,000,000	36,333,333
Unified Plant	30.75	3,020,000,000	100,000,000

The first conclusion was that there was immediately available, in addition to the demands of the Norfolk County Water Company, a surplus of 2 m.g.d. for the City of Norfolk. The second conclusion was that, until Lakes Bensten and Phillips, which had then been acquired by the City of Norfolk, were developed and made available, the city was long on storage and short on catchment area, while the Norfolk County property was long on catchment and short on storage.

Not only have these findings been abundantly sustained by subsequent developments, but the acquisition of the works by the City of Norfolk was of great economic value in providing for the increased demand of the war period.

During 1920 I was commissioned by the City of Norfolk "to study the existing conditions of the present pumping station, ascertaining its present capacity, reliability and economy, with



The Pumping Plant as Rebuilt, with Lengthened Stack

view to recommending changes and additions necessary to create a modern, reliable, and efficient station capable of meeting an ordinary demand of 15 m.g.d., with sufficient duplicate capacity to assure continuity of service and ability to meet the fire demand, with recommendations as to type, location, and quality of equipment, accompanied by an estimate of costs of same."

The stack of the pumping plant was found to be sufficient in diameter for the desired boiler capacity, but insufficient in height to produce a proper draft. Its height was therefore increased from 100 to 150 ft.

Since the boilers then supplying the plant were the return tubular type, of considerable age, constructed for lower pressures, they were considered unreliable and totally inadequate to meet the demands of modern practice. As a consequence, three new water-tube boiler units, with superheaters, were installed, and all the old units were discarded.

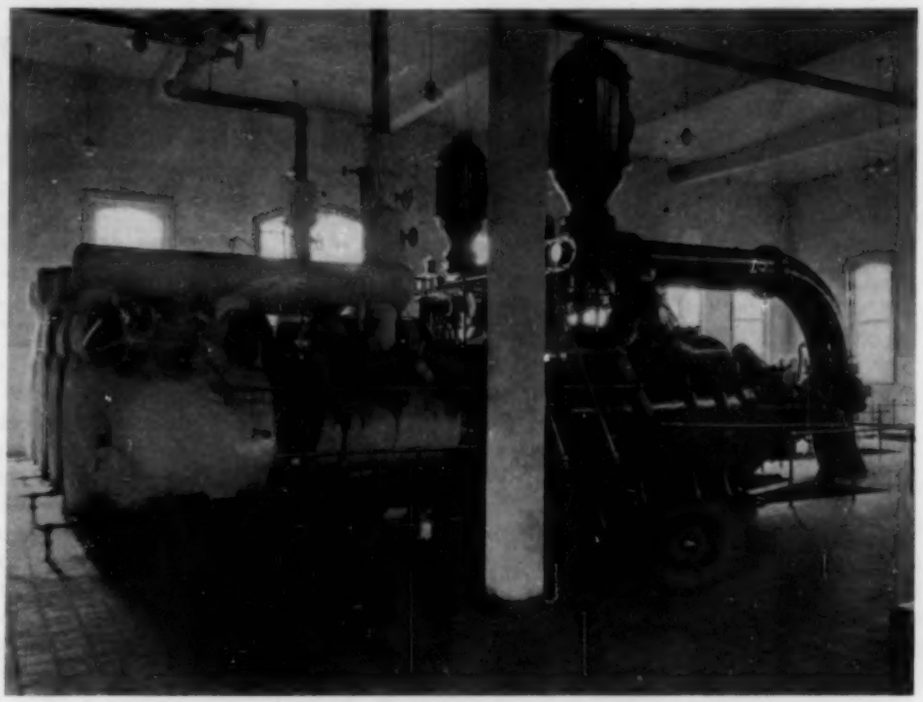
The youngest pumping engine in the station, a 10-m.g.d. direct-acting compound high-duty Worthington, and a similar Worthington of 5-m.g.d. capacity, had been in service 30 years. A 5-m.g.d. Holly-Gaskill engine had been in use for 40 years. All were in fairly good condition, but it became apparent that in order to create space for a modern unit, it would be necessary either to build an addition to the pumping station or to discard one of the old units. Inasmuch as the two Worthingtons provided the necessary 15 m.g.d. of reserve capacity, the Holly-Gaskill was discarded, and in the space it had occupied was erected a cross-compound Snow-type engine of 15 m.g.d. capacity.

The following tabulation will serve to give some idea of the performances of the several types of steam pumps.

Service	Capacity in Gal. per 24 Hours	Builder	Type	Duty in Ft-Lb. per B.t.u.*	Efficiency in %	Slippage in %
Low	10	Worthington	D.a. Triple	46.5	..	..
Low	8	De Laval	Turbine-Driven Centrifugal	32.3	..	..
High	10	Worthington	H.D. Compound	90.2	87.7	9.1
High	5	Worthington	H.D. Compound	74.8	94.4	9.6
High	5	Holly-Gaskill	Cross-Compound Crank and Flywheel	69.5	96.0	43.4
High	15	Snow-Worthington (new)	Cross-Compound Crank and Flywheel	136.6	..	0.8

* By Displacement

One of the problems which arose was that of convincing the operators of the plant that the Worthington high-duty engines could be operated in parallel. Since I had at one time been an engineer on the Worthington staff and was familiar with the peculiarities of the compensating, or tail-pincher attachment, I realized that some minor changes would overcome the difficulties that had been encountered in the past and enable these two engines to constitute the necessary reserve unit of 15 m.g.d. capacity. This they have done satisfactorily from late in 1921 to the present time.



NORFOLK'S WATER WORKS
A 30-Year-Old Worthington Pump of 10-m.g.d. Capacity

The demands made upon the plant became materially greater during the war period, when it was difficult to obtain steam pumping equipment within a reasonable time. Consequently, electrically driven pumps were installed to supplement the steam equipment both on low and high service. The favorable performance of slow-moving low-head pumps is well exemplified by the record of the 15-m.g.d. pumps acquired at that time. These pumps showed an over-all water-to-water operating efficiency of 71 per cent when tested under a 36-ft. head, which corresponds to normal operating conditions.

At the same time, the severe limitations of the centrifugal type were brought out by the 5-m.g.d. high-service motor-driven pumps, which were placed directly on certain outlying services, where fluctuations in demand and pressure were immediately transmitted to the pumps. In consequence, the best operating head was attained only occasionally, and at most other times the pumps operated at unfavorable points on their characteristic curve. The result was an average efficiency of only 41.7 per cent.

Since the steam feed and drain lines were all very old, an entire new piping system and a new feedwater heater were provided, and the entire system was modernized. The result was a material saving in coal to the city, besides an improvement in the capacity, the reliability, and to a marked degree, in the appearance of the plant.

Results of Experimental Work on Sewage Disposal

Committee of the Sanitary Engineering Division Reports on Progress at New Jersey Experiment Station

A COMMITTEE of the Sanitary Engineering Division of the Society was appointed several years ago to report from time to time on the progress of the experimental work being carried out by the Department of Sewage Disposal of the New Jersey Agricultural Experiment Station. The first progress report appeared on page 185 of PROCEEDINGS *for April 1927, the second on page 599 of* PROCEEDINGS *for March 1929, and here follows a digest of the report of this committee which was read before the Sanitary Engineering Division of the Society at the Norfolk Meeting. In this digest are presented the results and conclusions of experiments carried out during 1930 by Dr. Willem Rudolfs, M. Am. Soc. C.E., Chief of the Department of Sewage Research. The report has been prepared by George T. Hammond, M. Am. Soc. C.E., of Brooklyn, Chairman of the Committee, and by William R. Copeland, Affiliate Am. Soc. C.E., of Hartford, Conn. So much interest was shown in the report that it is to be printed in full in* PROCEEDINGS.

TEMPERATURE plays an important part in the rate of digestion of sewage sludge. The period required for digestion decreases as the temperature is increased, as shown in Table I.

TABLE I. RELATION OF TEMPERATURE TO DIGESTION OF SLUDGE

TEMPERATURE DEG. FAHR.	NUMBER OF DAYS REQUIRED FOR DIGESTION
55	120
68	42
82	30
100	12
140	1 to 4

At temperatures of from 120 deg. fahr. to 140 deg., many of the kinds of bacteria which exist in normal sewage are destroyed, and their places are taken by certain species of thermophilic bacteria. These organisms digest the sludge at an exceptionally rapid rate, giving off carbonic acid and marsh gas in about the same total volume as when digestion takes place at lower temperatures, but at a more rapid rate.

Sludge may be said to be ripe, and therefore ready to draw off, when the volatile matters are reduced from 50 to 60 per cent and the ash is increased to 45 or 50 per cent. Such sludge drains freely, has only a slight tarry odor, the water which drains off is clear, and its bio-chemical oxygen demand is reduced to from 500 to 700 parts per million on 5 days incubation. The reaction of ripe sludge varies from pH 7.2 to pH 7.6.

To secure complete and rapid digestion, the fresh, or green, sludge should be mixed with predigested ripe sludge in the proportion of two parts (dry weight) of green sludge to one part (dry weight) of ripe sludge.

Recirculation of liquor which has been in contact with ripe sludge, and the addition of small doses of commercial hydrate of lime, tend to prevent foaming caused by the development of excess of acid in the digesting sludge, to maintain the pH value at from 7.2 to 7.6, and to prevent the formation of thick layers of floating scum in the digestion tank.

Centrifugal pumps "thrash sludge to pieces." Therefore, the plunger type of pump is better suited for pumping sludge to drying beds.

A moderate amount of stirring sludge, retained in digestion tanks at from 70 deg. fahr. to 85 deg. fahr., results in mixing the ripe and green sludge together intimately and causes the gases given off to escape from the sludge at uniform rates. But when sludges are digested at high temperature, the gases are given off so rapidly that they agitate the sludge sufficiently, making "mechanical stirring" unnecessary.

Animal, fish, and vegetable oils, and fats, greases, and soaps digest readily in sludge digestion tanks when the temperature is maintained above 85 deg. fahr. They produce a large percentage of CH_4 (marsh gas). At lower temperatures it is desirable to remove the oils and greases by aerating and skimming the raw sewage.

Biological processes of decomposition, which take place in the course of sludge digestion, are made possible chiefly by the development by bacteria of enzymes which break down the complex organic materials into simpler bodies, into forms which the bacteria can absorb.

Liquid chlorine may be added to raw sewage, for the purpose of killing slimes and preventing the development of foul odors, without inhibiting sludge digestion, provided the chlorine is not added in sufficient quantity to produce "residual chlorine" in the sewage leaving the settling basins.

Samples of liquor taken from different depths in trickling filters made from crushed trap rock, gravel, and slag, were analyzed. The results showed that, for all practical purposes, equally good purification may be obtained from each of these three types of filter media, as shown in Table II.

TABLE II. DIFFERENT FILTER MEDIA COMPARED

KIND OF MEDIA	PER CENT OF REDUCTION B. O. D.	B. Coli
Crushed Trap Rock	82	74
Slag	75	74
Gravel	77	93

Tests showed that currents of air pass from the top to the bottom or from the bottom to the top of beds in sewage filters, depending on whether the outside air is warm or cold, and whether the barometric pressure is high or low.

It has been found that the number of times that a trickling filter will unload in a year depends upon the amount of organic matter applied. The unloading characteristics of gravel, slag, and crushed trap rock are similar, no difference being apparent due to the roughness of the surface of the pieces.

Filters which receive large volumes of strong sewage unload several times a year. Filters which receive weak sewage, and therefore have to handle only comparatively small amounts of organic matter, will unload not more than once a year and perhaps not at all.

The composition of natural waters differs so enormously, and the natural salts dissolved in them vary to such a degree that bio-chemical oxygen demand tests should be made by using a buffered dilution water, that is, a water which has been stabilized by the addition of sodium carbonate and by pre-storage for several weeks.

Little real scientific knowledge has been secured concerning the exact agencies that control sewage digestion by activated sludge. Therefore the station force has started an exhaustive series of tests—biological, chemical, and physical—to find out what agencies are really fundamental in securing good purification of sewage by activated sludge.

Many samples of the raw sewage, treated sewage, and sludge have been collected at the Plainfield Sewage Disposal Plant. These have been analyzed and the results may be summarized briefly in Table III.

The plant handles from 3.5 to 3.7 m.g.d. (millions of gallons daily) of sewage from 50,000 people.

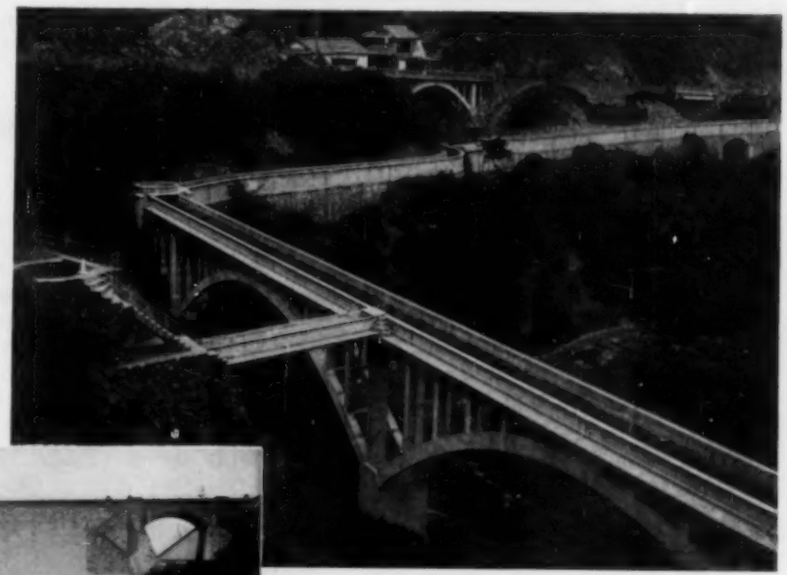
TABLE III. ANALYSES OF RAW PLAINFIELD SEWAGE

Total Solids	900 parts per million
Suspended Solids	250 parts per million
B. O. D.	220 parts per million

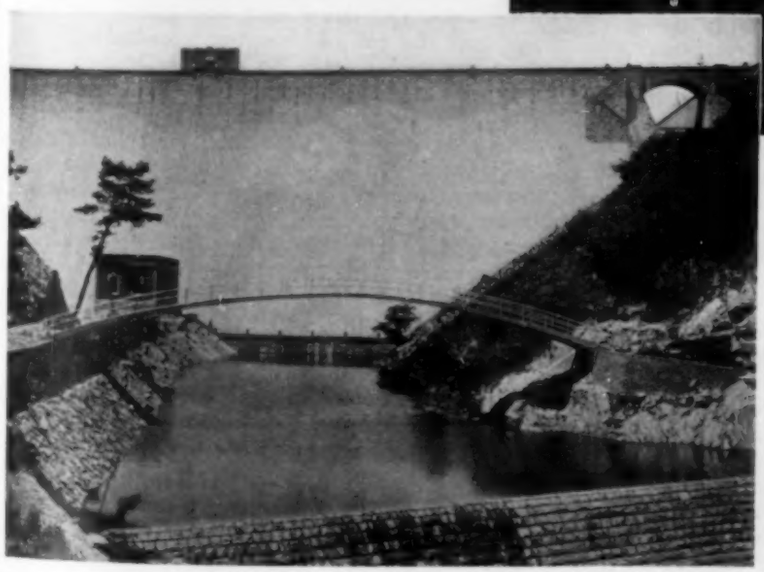
From this sewage 1,600 to 2,000 cu. ft. of wet green sludge were obtained each day. This was pumped into three separate sludge digestion tanks. The reaction was controlled by adding about 100 lb. of hydrate of lime daily and the temperature of the sludge was kept up to from 70 to 72 deg. fahr. by circulating water heated by burning the gas given off by the digesting sludge. This hot water was circulated through coils of pipe hung on the walls inside of the tanks. After 30 days had been allowed for digestion, the digested sludge was run off onto open sand and gravel sludge-drying beds, where the moisture decreased from 87 to 65 per cent in about 15 days.

Screenings raked off from the bar screen and the fine screen, and the digested sludge, when buried in furrows a few inches deep and covered by an inch or two of fertile garden top soil, changed to a black non-odorous humus in 12 months time. But screenings and sludge which were buried deep in the ground, away from the air, remained undigested for more than 18 months.

Kawachi Water Works
Japan



THE AQUEDUCT
Seen Against a Picturesque Setting



KAWACHI DAM
Thin Arch Bridge in
Foreground

Photographs furnished Courtesy of
HISANORI NUMATA, M. Am. Soc. C.E.

OUR READERS SAY—

In Comment on Papers, Society Affairs, and Related Professional Interests

Engineering to Prevent Fires

TO THE EDITOR: In "Safeguarding Industry Against Fire," published in the February issue, H. E. Magnuson calls attention to the progress made by engineers in the practical art of fire prevention in industrial properties. In a broad sense, insurance costs may be likened to dues or taxes contributed by the members of any group or organization, associated for a common purpose. As taxes are levied on individuals or individual concerns, for the purpose of obtaining certain common benefits, so do the individuals who are insured contribute for the purpose of obtaining indemnity against common hazards. Obviously, insurance is a tax on business, the contribution varying in proportion to the risk.

DISTRIBUTION OF INDIVIDUAL LOSSES
Factory Mutual System, 1930

If fire losses can be prevented, and not simply distributed, to be absorbed again in the cost of fire insurance, the benefit to manufacturers is twofold: first, the preservation of property and enhancement of continued profitable use and occupancy; and second, a diminishing loss ratio, which tends to reduce the tax or contribution for this indemnity. It is recognized, therefore, that the best development of insurance lies in the principle of contribution for fire prevention, a positive purpose, rather than in the collection of a tax to absorb losses, which is a negative result.

In the Factory Mutual System of fire insurance, manufacturers are associated in a cooperative effort to reduce fire losses, through the application of engineering principles to fire prevention. By maintaining high standards, the loss is controlled and, through the mutual principle, the benefit is passed on to the insured. Through segregation into a special class, members share in the benefits of extremely low loss ratios and enjoy practical immunity against interruption to business. That this principle of underwriting is fundamentally sound and economically successful is indicated by the fact that fire loss on highly protected industrial property has been reduced to less than 2 cents a year for $100 of risk.

The experience of the companies who promote and develop industrial insurance indicates that in a carefully protected group of risks, which now number close to 8,000, about 90 per cent of all fires occurring can be extinguished by less than a half dozen sprinklers, and the loss is practically the cost of cleaning up, rather than that of replacement of destroyed values.

In spite of all precautions, however, large losses do occur. But these are infrequent, and the result of carelessness or failure on the part of the human element, which renders the fire protection inoperative or ineffective. However, underwriting results, based on 95 years of service to manufacturers, lead to the definite conclusion that modern plant fire protection pays, through assuring the owner fully 98 per cent immunity against fire damage, the fullest security for profitable operations and continued earnings, and rewards of the lowest costs for insurance.

S. R. BELLOWS, Assoc. M. Am. Soc. C.E.
Assistant Vice-President and Engineer
Blackstone Mutual Fire Insurance Company
Providence, R.I.
April 28, 1931

Experience with a Traveling Bridge Pier

TO THE EDITOR: The article by Mr. Purdon, in the February issue, brings to mind my own experience with traveling piers. One, in the estuary of the Merrimac River at Newburyport, Mass., gave a great deal of trouble before it was provided with additional support. It was a small round pier of good granite masonry on piles, built for a turntable, single-track wooden drawbridge. In 1888, an iron-deck, double-track pivot draw was built on the little pier, which soon began to tip to the east nearly in line with the track. The freeway between the draw and the track was soon closed up, and the job of chipping for clearance and leveling up the spider track on the pier began.

After some years of this work, 8 or 10 good oak piles were driven around the weak side of the pier close to the masonry, care being taken to drive them so that their heads would rest against the stonework. Heavy cast-iron caps about 2 ft. high were then set on the piles, which had a stout bracketed lip, the top of which was let into the stone. The piles were cut off at about half tide, and an anchor bolt fastened with a witch wedge secured each pile to the masonry. Plank sheeting was then set outside the piles, and the whole space among the piles and castings was filled with concrete, that below low tide being placed with a tremie. Since then, the small pier has remained in place, although the bridge has been strengthened with additional trusses and the weight of rolling stock increased 50 per cent.

J. P. SNOW, M. Am. Soc. C.E.
Consulting Engineer
Boston, Mass.
April 25, 1931

Difficulty in Railroad Construction

TO THE EDITOR: The paper by Mr. Purdon on "A Unique Bridge Over a Unique River," which appeared in the February CIVIL ENGINEERING, is especially interesting to engineers who have spent much of their time in constructing or maintaining structures over streams of this character.

Since the banks and stream bed are unstable and apt to move when saturated, it becomes necessary to balance the loads around the piers to prevent their displacement by slides or flowing stream beds.

In the hurry of constructing a new railroad, particularly when there are only short working periods between flood seasons, it is not always possible to do all of the things that good judgment may indicate, and some dependence must be placed on the probability that foundations will remain stable, or move within limits that will permit the structures to remain in service.

The ingenuity and resourcefulness of the engineer are shown by the methods he adopts to overcome difficulties, and this is especially true when the work must be done under adverse conditions, such as high water, rain, lack of suitable machinery and supplies, and often, of help.

The quick time in which a railroad was put across the stream under Mr. Purdon's direction is typical of his character and ability as an engineer.

W. H. KIRKBRIDE, M. Am. Soc. C.E.
Engineer of Maintenance of Way and Structures
Southern Pacific Company

San Francisco, Calif.
April 24, 1931

Chinese Engineering Methods

DEAR SIR: As Mr. Lane has pointed out in the February issue, I am sure that any traveler in China will be impressed with the bridges. Some of the most beautiful examples of stone arch bridges are to be found in the interior, far from any important lines of travel. Although most of these are semicircular in form, as is shown in the photograph, one in which the rise is considerably less than half the span is occasionally found.

TWO 24-FT. ARCH SPANS OF THE USUAL SEMICIRCULAR TYPE

The bridge referred to crosses a small tributary of the Tsien Tang River, far from usual travel routes.

Before passing over one of these bridges, it is well to consider the traffic situation, especially if one is riding in a sedan chair. There is not often any congestion but, if one of the quiet, meek-looking water buffalo, so common in Central and Southern China, is coming, it would be well to wait until he passes off the bridge, as a meeting at midstream on the 50-in. unguarded roadway might be disastrous. Water buffalo are led around, ridden, and even disciplined by children, but if strangers display any intention of crowding them in the open road, trouble starts at once. There is a swift dash, followed by cracking of the bamboo work of the chair and the knocking over of the coolies. Then there is a calm resumption of the deliberate gait of the attacking animal, which does not exceed one mile an hour.

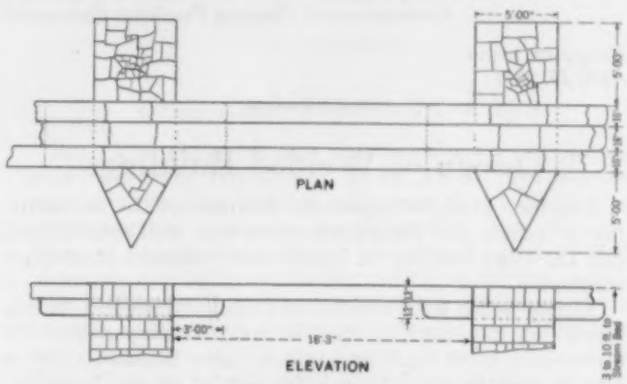


FIG. 1. THIRTEEN-SPAN STONE SLAB BRIDGE
Crossing the Da Chi Pien, Chekiang Province, China

The absence of the use of the truss in old Chinese buildings is noticeable, and it is doubtful if its principles were known. Although many roof supports give the impression of truss construction, close observation discloses the fact that they consist of multiple beams of gradually lessening length and vertical struts. With stone, brick, mud (for walls), and timber constituting the only building materials for heavy construction, it is not strange that the truss was not used.

Many Chinese cities are still practically untouched by Western customs excepting that on every hand are seen evidences of the good salesmanship of a certain well known sewing machine company and of an even better known petroleum company. If we judge from the many novel uses of empty oil cans, it would appear that the ingenuity of the Chinese did not die with the ancients. These old tin containers may serve in practically their original form or, cut in half diagonally, they make excellent dust and ash pans. Cut open and beaten out flat, they furnish a much needed and cheap sheet metal for many purposes.

In passing through the streets of cities in the interior, one is constantly impressed by the ingenious use of stone and the patience exercised by the old stone cutters. The main street of Yung Kia, more than 4,000 ft. in length, is paved with square slabs, the central row being fully carved in intricate designs. Flat slab bridges are seen in most sections of the country. These are usually of the type indicated in Fig. 1, although one is occasionally seen in which the slabs are placed on edge, as girder beams, with a floor system of shorter cross slabs placed on these.

For many generations, salt wells were drilled in Szechwan Province, some of these exceeding 3,000 ft. in depth. A steel bit was used, and possibly a short section of rod to give the required weight for drilling, but long drill rods were unknown. The cable was of twisted strands of split bamboo, while human labor furnished the power. The drilling of one well extends through years, sometimes being completed by the third generation.

Although the long periods of splendid achievement by the Chinese have been broken by occasional periods of stagnation, or even retrogression, it seems obvious that the conditions of the past generation or two are but a passing phase and that, in a relatively short time, present difficulties will be surmounted and the country will take its place as a leader along those lines in which its people are peculiarly fitted to lead.

ARTHUR M. SHAW, M. Am. Soc. C.E.
Consulting Engineer, National Construction Commission and Chekiang Provincial Government

Hangchow, China
April 25, 1931

Design of Welded Buildings

EDITOR: Certain important features of the arc welding of trusses and plate girders are now well established, but the field welding of beams and columns is another matter.

A steel beam with riveted end connections is a simple beam, as assumed in the design. It slopes slightly downward from each end, since there is some play in the riveted joints. In solidly welded work, however, each beam becomes a fixed-end beam. Such a beam is never simple.

We get the impression that welded beam ends have some sort of welding throughout the depth of beam and probably a welded seat in addition. At times we hear that the seat is sufficient to take the entire beam reaction and that, besides welding the bottom flange to the seat, there is stitch welding in the upper part to hold the beam to line. That makes a good seat but a poor job. The stitch welding cannot stretch. As long as the connection is intact, the welded section must resist the maximum bending of the beam. If it tears loose, nothing remains except the seat, in which case we have a simple beam, but little stability to the structure.

In a simple-span steel beam, stressed by uniform load to 18,000 lb. per sq. in. at the center section, a vertical section at the end of the unstressed beam is pulled out of the vertical by $^1/_{16}$ in. for each 10 ft. of span. For 30-ft. beams, irrespective of depth, each beam top will move $^3/_{16}$ in. away from its original position if the bottom is welded to a seat. The resulting $^3/_8$-in. crack in a concrete floor slab would be comparable to the one recently observed in a garage building where an ugly opening ran along the line of each girder and continued up the concrete fireproofing around columns. Such cracking would be eliminated if all beams could be connected by 100 per cent welds, producing a thoroughly continuous structure. The question is can this be done and will the building stand?

It would be difficult to secure a 100-per cent weld of a beam placed closely beneath a girder flange. There would be greater difficulty in the case of a coped beam of flush-top work, when the center of the beam flange was thicker than the edge of the girder flange. Also, a large beam crowded into the web of a narrow column would cause trouble, which would be increased if the beam was not centered on the column. If these details are practical, I would like to know how to secure good work at low cost.

When heavy beams are welded to the opposite flanges of a column, the negative bending must be taken entirely by the column web unless the column is reinforced by expensive welded diaphrams. To illustrate, a 22-in., 58-lb. beam is welded to each flange of an H-column having a web thickness of 0.31 in., and the beams are stressed to 18,000 lb. per sq. in. If this bending is resisted by a 24-in. height of column—and we cannot fairly assume more—the fiber stress in the column web is 75,500 lb. This tends to split the web at the beam tops and to buckle it at the bottom.

What happens? Will the welds tear loose, or will they hold? If they hold, they will split the column. The saving assumption is that the structure will never be required to carry the stated load. I am convinced that many structures of various types continue to stand up because they have never been fully loaded.

We hear considerable talk concerning the field welding of structures that have been designed for the usual riveted connections. A structure should never be welded unless it has been designed with this end in view. Otherwise, we can expect split columns and other failures. There is no saving grace in the fact that the beam is strong enough to carry its load as a simple beam. If its ends are fixed, it is a fixed-end beam, and its ends must take the full maximum negative bending or break loose. That is what happens to some concrete beams that have been "designed" as simple beams. A fixed-end beam is a fixed-end beam, and argument does not alter the fact.

This letter is not a criticism or discussion of any writings on the subject of welding, but rather a quest for further light on the matter. Will the advocates of welding—those men best informed on the subject—tell us how to weld beam and column jobs?

LEONARD C. JORDAN, M. Am. Soc. C.E.
Consulting and Designing Engineer

New Rochelle, N.Y.
May 3, 1931

Difficult Factors in Subway Work

DEAR SIR: I desire to write a few words of comment and discussion concerning the paper by Howard F. Peckworth in the April issue.

The greatest difficulty in connection with the work was that the design called for a depressed track for the full length of the station—that is, 1,100 ft.—with its westerly neat line only 6 in. from the building line, and with its subgrade between 50 and 51 ft. below the curb level. It is thus seen that the support of this sheer bank, 50 ft. high and composed largely of rock of wide variation in character, necessitated the utmost care and attention on the part of all concerned.

I feel that, aside from this care and attention, the following three factors contributed largely to the successful carrying out of the work: (1) the seven longitudinal deck girders, as described by Mr. Peckworth, each of which, with 100 per cent splices at 40-ft. intervals, made a girder practically continuous throughout the length of the section of approximately 2,900 ft.; (2) the cross bearing girders every 20 ft. along the cut, acting also as cross braces from bank to bank, at approximately the level of the building foundations; and (3) the carrying of the foundations of the buildings above the pit level by the girder or girders, which acted as a longitudinal tie or "harness," as well as a support, beneath which pits to rock could be located at random within the limits of spacing, as called for by the modulus of the concreted girder.

While no especial significance can be attached to this fact, it is nevertheless true that all of these girders were of the sectional web-plate type originally designed to

have webs spaced with 30-in. openings and to come knock-down. It was, however, found more economical to have the longitudinals between street crossings come fabricated, that is, some 80 per cent were fabricated and the rest knock-down. The longitudinals were all 32 in. deep, with 6 by 8 by 1/2-in. chord angles and the cross girders were the same, except that the chords were of 6 by 8 by 7/8-in. angles.

These girders were forerunners of the present type of sectional plate girder which I designed for tunnel and underpinning operations and for other congested spaces. In this type, the spacing between web plates has been cut to a minimum of not over 5 in., thus giving a girder whose modulus is that of a plate girder with the modulus of the web subtracted.

J. C. MEEM, M. Am. Soc. C.E.
Consulting Engineer

Brooklyn, N.Y.
May 6, 1931

An Era of Regional Expansion

DEAR SIR: In his paper in the January number of CIVIL ENGINEERING, Mr. Greensfelder has shown the necessity of scientific planning. A regional planner and, to a lesser extent, a city planner must deal with many problems that are not strictly engineering. Mention of some of these may be of interest.

The recent growth of various modern regions has been to a certain extent unguided. There are to be found in such regions several quite distinct centers, both industrial and residential, which are of considerable importance and have been, for many years perhaps, quite distinct from the city around which they are grouped. For example, in the New York Region, there are to be found important New Jersey business and industrial communities across the Hudson River, and suburban residential communities in Westchester and other adjacent counties. In the Philadelphia Region are cities like Wilmington and Trenton, both important industrial centers; and in St. Louis there are the industrial communities in Illinois, across the Mississippi River, and such residential suburbs as University City.

Planning in such regions involves four major problems which will not be found in the average city planning abstract. The first is that of arousing a regional consciousness, which must precede regional cooperation. In Chicago, both have resulted. In New York, the activities of the Regional Plan Committee have, during the past ten years, aroused a very live regional consciousness, and I believe that an era of enlarged regional cooperation is under way.

Second, we must have the courage to limit extensive building development to that which can be accommodated by the surrounding streets, as there is a definite relationship between building bulk and street traffic. It is obviously ridiculous, for instance, to permit a very extensive building development upon small blocks and narrow streets, and then to find out later that it is impossible for the streets to serve such a development.

In the third place, I believe we should encourage the maintenance of communities. To me, there is nothing more monotonous than the sight of a long, unbroken community development, stretching as far as the eye can see. However, I believe it is perfectly possible to maintain a regional consciousness and to encourage and maintain separate regional centers, which will be closely related to each other and to the main center.

Fourth, we must find some way of avoiding the serious depreciation of land values and of improvements which takes place as a result of rapid and unplanned changes.

None of these four problems is strictly engineering, but I believe that they are all important and must be taken into consideration if regional planning is to be a success.

HAROLD M. LEWIS, M. Am. Soc. C.E.
Engineer, Regional Plan of New York and Its Environs

New York, N.Y.
April 27, 1931

Regional Planning Pays

SIR: The paper by Mr. Greensfelder, in the January issue, was very refreshing. It is rare to find someone who, while calling himself a layman, has such a broad conception of planning work. As he has described planning, it coincides with my own definition of it "as the conscious endeavor on the part of the governing agency to so regulate and coordinate the use of the property and natural resources of a community, and the distribution and circulation of the population thereof, as to obtain the highest social efficiency among the inhabitants."

Mr. Greensfelder has rightly placed emphasis upon the primary importance of the educational labors necessary in achieving a plan. Planners and planning commissions constantly lament that so many good plans are discarded or pigeonholed. No matter how meritorious a plan may be, it is not completed until it has been adopted and is in the process of being put into effect.

Regional planning is nowadays an accepted thing. The logical outgrowth of city planning was brought into prominence by the increasing mobility of the inhabitants of an area. Today there is hardly such a thing as the outskirts of a city—at least for any length of time. Even when outskirts do exist, they are constantly moving outward. So, following a logical course, city planning developed into the planning of metropolitan areas, and beyond that into regional and even state planning.

The scope of subjects to be considered in planning regional expansion, as given by Mr. Greensfelder, is very broad, and rightly so. I wish that the importance of the necessary investigations could be impressed upon city or county officials responsible for appropriating funds for such studies. In very few cases have I seen sufficient funds made available for investigating even a portion of the suggested field, yet there is no question but that a dollar spent in proper planning will save many hundreds later on. For instance, during the three years 1927 to 1929, inclusive, the City of Los Angeles expended approximately $33,000,000 for the acquisition of 7,800,000 sq. ft. of property and resulting damages in the opening and widening of major traffic arteries. This necessary expenditure resulted almost entirely from lack of planning in the early subdivision development of the city.

During this same period, in the subdivisions recorded, there was dedicated, for major or secondary highways, an area in excess of the usual 60-ft. dedication width, totaling 7,050,000 sq. ft. The sole cost to the city of this excess street area, which resulted in an arterial highway system of adequate width and proper location, was the establishment of proper subdivision control by the City Planning Department, the cost being approximately $30,000 for the three-year period. It can well be argued from these figures that the return upon the investment

made in proper planning was almost 1,000 to 1. It is experiences such as this which can be used with great effectiveness in educational work, in selling the idea of the city plan, and in raising funds to insure adequate study of it.

I hope that Mr. Greensfelder's paper will be widely read by so-called laymen in planning work, as it will be very helpful in broadening their ideas of the work. Too many planning commissioners still consider planning as nothing more than keeping gas stations out of residential neighborhoods and eliminating jogs in streets in new subdivisions, and as long as this constitutes the scope of the term in the minds of planning commissioners, planning will do nothing more than just this.

DONALD M. BAKER, M. Am. Soc. C.E.
Consulting Engineer

Los Angeles, Calif.
April 18, 1931

Engineering and Community Health

EDITOR: The first reaction to Mr. Knowles' paper, in the February issue, is a feeling of regret that he should have commented so pointedly on Pittsburgh's engineering failure in sewage treatment. He might well have stopped with his recital of the city's engineering achievement in the conquest of a difficult terrain and of its achievements in highway, bridge, tunnel, and railroad construction, and last, but not least, in water purification.

A second reading produces a different reaction. We frequently make real progress by a study of our engineering failures, and there is no question but that our community has fallen down in the disposal of its industrial and municipal wastes. This failure has not been due primarily to a lack of knowledge of methods, but to a lack of public demand for the application of such knowledge. It is comparatively easy to secure appropriations for the engineering objects which directly benefit a community. It is likewise easy to secure appropriations for leading municipal and industrial wastes by means of sewers to a point outside the community.

Our municipalities, however, are not yet educated to the point where they realize the injustice of sweeping their refuse into their neighbors' yards. Public opinion has not reached the stage where our municipalities realize that they are parts of a commonwealth and that a vital factor in this commonwealth is common health. The protection of a downstream community from the evils of community refuse is as much an ethical duty as the establishment of proper facilities for religious and secular education. We cannot teach the golden rule in our schools and fail to practice it in our communities.

Nor can we shift the responsibility by saying that a state department of health has failed to force action. No public body can rise above public opinion; no legislation is enforceable unless a strong, enlightened public opinion is back of it.

Who better than the engineer can help to form this opinion? He realizes the evil results of polluting our streams and knows how this pollution can be controlled or prevented. It is his civil and professional duty to his community to lead engineering progress in this direction, which is as important as that mentioned by Mr. Knowles.

LOUIS P. BLUM, M. Am. Soc. C.E.
Blum, Weldin and Company
Engineers and Surveyors

Pittsburgh, Pa.
April 20, 1931

What the Planner's Qualifications Should Be

EDITOR: The article by Mr. Knowles in the March issue brings to mind several thoughts. A city or a region is dynamic. Heisenberg's principle of uncertainty applies to both as it does to an atom. Each has either velocity or position—the more velocity the less position, and vice versa. The more static the city, the less it can grow or evolve. It can have both position and velocity at different moments or in different phases.

No other professional man is as conversant with dynamics as is the engineer, so he should be the most important of planners. He must remember, however, that all human life enjoys beauty and that there must be beauty in every construction. From an engineering point of view, I think that Santayana was right when he said that if a thing is intrinsically adapted to its needs it is beautiful.

Therefore, the city should have either an engineering artist or an artistic engineer for its planner. Although I do not profess to be either, I had the honor some years ago of being invited by the president of the American Water Works Association to prepare a paper on the esthetics of water works structures. It was interesting to discover how very little it takes to make a beautiful dam, or water tower, or reservoir, and that great improvements may be made in the design of such things as hydrants and the better known water works structures. The same principle applies to all city fixtures.

The planner must be a sociologist and administrator. He must have the capacity to differentiate values. He must also be an economist, as the relationship of structures to the ends they are to serve is his problem. Finally, the planner should have some legal knowledge.

E. P. GOODRICH, M. Am. Soc. C.E.
Consulting Engineer

New York, N.Y.
April 30, 1931

Water Purification Methods

TO THE EDITOR: I have read with great interest Mr. Weston's paper, "Purifying Water for Domestic Use," in the December issue. A few words regarding our experiences with the Wanaque Reservoir during its first eight months of use, from March to December 1930, may be of interest to your readers.

Wanaque Reservoir, located in northern New Jersey and holding some 27 billion gallons of water, depends for purification primarily on storage. The efficiency of this method is shown by the fact that, for eight of the ten months that the reservoir has been in service, the water would have met the Revised Treasury Standard for drinking waters without chemical disinfection. During the remaining two months of September and October, gas-forming bacteria made their appearance. These grew at the transition zone, apparently in connection with decomposition of organic matter derived from the bottom of the new reservoir. It is the practice to add chlorine as the water goes into the aqueduct as a safeguard against any bacteria which might survive the eight months of storage.

Depth samples taken during the latter part of the summer stagnation period showed that the oxygen had been entirely depleted, from a point 30 ft. below the surface to the bottom, and that considerable hydrogen sulfide and carbon dioxide had been formed. They also

showed that in these lower depths relatively large amounts of manganese and iron had gone into solution. These chemical and biological changes tended to raise the color of the water and to otherwise depreciate its esthetic qualities to such a degree that it became desirable to seek a better layer of water.

Such a layer was near the surface, but it contained odor- and taste-producing plankton. The plankton were killed with copper sulfate so that, before the quality of the cool mid-depth water which had been used up to this time became too objectionable, it was possible to use the warmer but more agreeable surface water. The same changes which affected the taste of the mid-depth water created such a chlorine demand that, at one time, it became necessary to add a relatively large amount of this chemical in order to maintain the amount of residual chlorine required by the state department of health.

Carbon dioxide, resulting from the oxidation of organic matter, rendered the water extremely corrosive and almost without warning caused widespread "red water" complaints. The trouble was overcome by the addition of lime in small doses, and gases of decomposition were neutralized by treatment with chlorine.

Practically every surface water offered to the public today is purified by one or more means. At first glance, it may seem that the task of building the structures for the collection of the water is the most difficult factor in a modern water works. However, once water is impounded, new forces begin to work; and these must be studied and controlled continuously to maintain a product of the purity demanded by present-day conditions, especially during the first few years of operation.

A. E. GRIFFIN,
Analyst in Charge of Water
Laboratory of North Jersey District
Water Supply Commission

Pequannock, N.J.
April 19, 1931

Utilizing Waste Areas

EDITOR: The article by Mr. Horner, in the January issue, emphasizes by a very apt illustration what I consider to be a fundamental aspect of municipal drainage—that is, the relation between the usefulness of land and the cost of drainage. It is necessary in a brief comment to limit the discussion of the term drainage to surface run-off, which is generally free of polluting substances. Sewers should obviously be built at any cost, but the economic aspects of drainage are often the determining influence in the design of storm-water sewers. A suggestion is made by Mr. Horner that the separation of sewage and storm water be made relatively secure by providing capacity in the sanitary sewers for roof water. Thus, in structures relating to drainage and the protection which they afford the marginal lands, relative costs are a major factor.

As developed by Mr. Horner, the subject relates primarily to valley lands, rather than to uplands, and thus to cities with relatively rugged topography. Cities that are comparatively flat and have few well defined valleys do not offer, to any great extent, opportunities for setting aside valley lands for drainage purposes. Occasionally, there are areas which should be left permanently without sewers. These are upland depressions or large flats, so located as to cause great expense for sewerage and drainage. If such areas can be raised, it will often prove economical to purchase them for use as a forest, wild life preserve, or park.

According to Mr. Horner, it is obvious that, in many cases, favorable costs may be secured by using valley lands for drainage. Also, the use of such low areas for the disposal of clean wastes may often be of value, as there is much city refuse which cannot be disposed of except by dumping. I believe that this is a proper use, provided, of course, the area is suitably maintained. The refuse dumped should not contain much rubbish nor more organic matter than can be safely assimilated.

Dumps for such waste are becoming scarce in many cities, so that long hauls and costly transportation are necessary for the disposal of it. To use land for dumping requires the construction of closed drainage conduits and thus does not permit the acquisition and use of the natural ground surface for drainage. The value of such lands for dumping should, therefore, be considered in the cost balance.

Among interesting examples of the use of valley lands, Mr. Horner has spoken of the development of Turtle Creek, in Dallas, which is one of the most attractive parkways in a residential district with which I am familiar. In this case, however, there have been administrative difficulties in keeping the storm flow within the capacity of the sewers, and the open waterway has been fouled, from time to time, with sewage. Open channels for storm drainage have been developed by the sewerage commissions of Indianapolis and Syracuse. I have occasionally sought to interest park boards in the acquisition of natural open channel lands for park purposes, as at Belleville, but without marked success.

An extreme case was a proposal made some years ago to cover the Chicago River through the business district so as to provide a wide automobile roadway through the city. The project was not feasible, but indicated the great value that was placed on channel land for transportation as compared to drainage. I have, on several occasions, found it desirable and sound to recommend the construction of drains in steep valley bottoms so as to provide dumps for clean ashes, as was recently done at Schenectady, N.Y.

SAMUEL A. GREELEY, M. Am. Soc. C.E.
Pearse, Greeley, and Hansen

Chicago, Ill.
May 1, 1931

Hydraulic Jump Effective

DEAR SIR: The article by Mr. Ewald in the March issue should be of great interest to engineers, as there is no problem of more vital concern to the designer of an overflow dam than that of disposing of the enormous energy resulting at the toe of the dam from the overflowing water.

I agree with Mr. Ewald that the hydraulic jump in connection with a properly designed deflection bucket is generally the best means of disposing of the energy of the overflowing water at the toe of an overflow dam, and of avoiding erosion. The nearer the jump can be brought to the toe of the dam the less expensive the control becomes. Where the normal water depth below the dam is not sufficient to bring the hydraulic jump close to the bucket, it is desirable to create a pool at the toe, either by means of a secondary dam or a depression of the channel adjacent to the toe. If natural action is relied upon to create a pool, the excavation for the base of the dam should be extended below the depth to which the pool will be excavated and the lip of the bucket placed at the proper elevation. This

depth can rationally be determined by either of Mr. Ewald's formulas or by the Kennison formula, also given in the March issue of CIVIL ENGINEERING.

Where the ogee type of overflow dam is used, it is desirable to have the elevation of the lip of the bucket fixed low enough to give the full or nearly full value of "d_2" above it at flood flow. The lip is sometimes placed at too high an elevation, which results in throwing the jump too far downstream for economy. An ideal elevation for the lip of the bucket is indicated in Fig. 1 in Mr. Ewald's paper. Excessive excavation may, however, sometimes prevent the ideal placement of the bucket lip. In such cases, a pool created by a secondary dam may be cheaper, either in connection with the ogee type of crest or the vertical-drop type.

In arch dams with overflow crests and in some overflow gravity dams, the vertical-drop type is sometimes best, but it must be observed that the falling water in this type produces an impact and scouring action on the foundation at the toe of the dam, while in the ogee type the impact action is largely obviated. On the other hand, the vertical-drop type generally has the advantage of bringing the standing wave close to the toe of the dam, where protection can be had, and this is not always easy to accomplish in the ogee type. In the use of the vertical-drop type, admission of air back of the falling sheet and an adequate water cushion are both necessary.

The admission of air, of course, prevents vibrations due to vacuum, and the water cushion breaks the impact on the foundation and gives head for producing flow downstream. The depth of cushion, therefore, should be great enough not only to prevent erosion due to the escaping water, as in the case of the ogee type, but also to prevent erosion from impact. This last requirement calls for a cushion somewhat deeper than that necessary to produce the hydraulic jump in the ogee type.

F. W. HANNA, M. Am. Soc. C.E.
Chief Engineer and General Manager, East Bay Municipal Utility District

Oakland, Calif.
April 27, 1931

Judgment Needed in Driving Piles

DEAR SIR: The paper by Mr. Everham, in the January issue, is timely and of much interest. Foundations are often subjected to greater loads than were contemplated when they were built; the economics of design must take into consideration the probable ultimate use of a particular foundation.

In many cases, piling serves the purpose at less expense than any other satisfactory type. There is a wide variation in the bearing power of piles as determined by many different formulas. The extremes of simplicity and complexity are illustrated by comparing the Wellington (Engineering-News) formula with that of Goodrich, explained in TRANSACTIONS, Vol. 48, page 180, both of which are based on the use of the drop hammer.

As stated by Jacoby and Davis, "the relation between weight of pile and that of hammer must be considered in any rational pile-driving formula." While much trouble and expense have been caused by the settlement of piles, Foster is undoubtedly correct in the statement that, "in many cases piles are driven to ridiculous depths simply because the jets will assist them there."

I believe the test pile is the best method of obtaining reliable information as to safe bearing value, but even in this test good judgment must be used. A pile driven in sand may test under a static load with no settlement and settle under the same load if vibrated. Again, in some soils a pile will support, for a short time, a load that would cause settlement if left on for a longer time. On the other hand, a pile driven into soft, wet soil will support a very great load after standing a day or two. A pile that acts as a column needs no more bearing power than its safe column load, but a long pile with little penetration is apt to settle from vibration.

A test of a single pile may not give a true value for a group of piles. It therefore behooves the engineer to explore the subsoil and consider the character of the load to be supported before interpreting test-pile data.

H. AUSTILL, M. Am. Soc. C.E.
Bridge Engineer, Mobile and Ohio Railroad Company

St. Louis, Mo.
May 1, 1931

Test on a Full-Sized Caisson

TO THE EDITOR: The paper on "When to Use Piling" by A. C. Everham, in the January issue, brings to mind such matters as the testing of surface soils and the effect of depth of hole on the resulting load, also the frictional resistance of piling.

During the construction of the Union Station in Chicago, we had occasion to make tests on the surface soil, and one such test gave an approximate result of 1 ton per sq. ft. After digging a hole down about 10 ft. through the same kind of soil, we placed the load at the bottom of the hole. It was found that the load could be increased about 500 per cent with no greater compression, proving the truth of the statement that the pressure has a great deal to do with the soil bearing power.

With regard to the frictional resistance of piling, we also made tests which gave the same data of frictional resistance of soils. Just prior to the entrance of the United States into the World War, we placed caisson foundations for a monumental structure. After the war, this was redesigned for a high office building developing different loads and greater concentrations.

In doing this, we naturally desired, where possible, to use the old caisson foundation, but the resistance was based on the building code rule of 6 tons per sq. ft. We submitted to the building department an agreement to carry out an elaborate test on a full-sized caisson, which rested on the hardpan at about −65, the hardpan being approximately 15 ft. thick.

Two caissons about 3 ft. in diameter were put down, one being belled out at the bottom as usual, and the second just a straight cylinder. The caissons were loaded up to 90 tons per sq. ft. with a resulting settlement of $1\frac{3}{4}$ in. When the load was taken off, the caisson came back about half this distance, indicating an actual settlement of about $\frac{3}{4}$ in. Therefore, in place of 6 it was possible to use 10 tons per sq. ft. on the hardpan.

After making the test on the straight cylinder, we tunneled over to it and excavated to a depth of about 3 ft. below the bottom of the caisson, then put the load on and pushed the caisson down. The frictional resistance resulting from this test was 800 lb. per sq. ft. of surface of the caisson.

ALONZO J. HAMMOND, M. Am. Soc. C.E.
Consulting Engineer

Chicago, Ill.
April 30, 1931

Coordinating Long-Distance Carriers

TO THE EDITOR: While I am in sympathy with much that Colonel Jonah stated in his paper on the coordination of terminals, I cannot follow his thought that, as a result of this coordination, buses will permanently handle a great proportion of the long distance travel. Whenever the railways see that it is to their interest to lower the fares for coach travel, then we may reasonably expect the bus to cease to be a factor in long distance travel. It will, however, continue important in short distance travel.

As to the consolidation of railways, the Interstate Commerce Commission has shown that it is hostile to that idea. Such coordination as may be expected to develop will be at natural division points—such as Cincinnati, St. Louis, and Pensacola—and not at intermediate localities.

In every coordination of terminals it will be necessary to make some adjustments, which will represent additional costs. In many places cost may make the whole project uneconomical and inadvisable.

JULIUS E. WILLOUGHBY, M. Am. Soc. C.E.
Chief Engineer, Atlantic Coast Line Railroad Company

Wilmington, N.C.
April 18, 1931

The Future of Terminal Facilities

DEAR SIR: I have read with interest Colonel Jonah's paper on "Coordination of Terminals," in the January issue of CIVIL ENGINEERING.

I know of no one better qualified than Colonel Jonah to present this subject, as he was chairman of a committee of engineers appointed by the St. Louis Chamber of Commerce, which submitted a report in 1922 on coordination of terminals in St. Louis and East St. Louis. Many of the recommendations contained in that report have since been adopted by the railroads and the city, and other of these recommendations are in the process of being worked out.

The proposition to have freight terminals and classification yards located outside of the cities is most desirable, and it is an end toward which the larger railroads are working. However, on account of competitive conditions in the handling of freight traffic, I do not feel hopeful of the conclusion of arrangements whereby a terminal company can satisfactorily handle freight traffic in a coordinated terminal in the same manner that passenger traffic is now so successfully handled.

Although Colonel Jonah believes that airport terminals will always have to be outside of city limits, I am of the opinion that the advance in the art of aircraft construction will be such that, in a comparatively short time, direct landings can be made within city limits or even on the roofs of tall buildings or above the train sheds of passenger terminals. In the latter case, direct interchange of passengers, mail, and express could be made between the air transport lines and the railroads.

In general, I consider Colonel Jonah's paper a distinct addition to the literature on terminal facilities.

E. A. HADLEY, M. Am. Soc. C.E.
Chief Engineer, Missouri Pacific Railroad Company

St. Louis, Mo.
May 2, 1931

Astigmatism a Cause of Error in Surveying

TO THE EDITOR: The recent interesting discussions of surveying methods in CIVIL ENGINEERING have brought to my mind a problem in connection with transit work, for which I will offer a solution. It is not uncommon to find transitmen who appear to suffer from a decided "personal equation," that is, their angular errors are accumulative, and always in the same direction. My theory is that this is entirely due to errors in reading the vernier, and that it is caused by astigmatism.

In the case of one man—incidentally one of the best transitmen whom I have known—I made a check by keeping separate notes, reading the vernier myself while he turned the angles, and comparing results after every four or five angles. This avoided hairsplitting discussions about any one angle. All angles were doubled and read to the nearest half minute. The results were startling, for they showed a difference of one or two minutes, usually accumulated by halves, at every comparison, and the difference was constantly in the same direction.

This man later bought glasses which corrected astigmatism, and his bearings, which had previously been out 6 to 8 min. for a day's run, showed excellent closures. Even with the glasses, however, he would occasionally go back to the old constant error. I observed the same thing in another man whose eyes were ordinarily all right, but who for several days at a time would show a constant error. I can think of no explanation for this except that the human eye is not always in perfect adjustment.

It has puzzled me to discover how any fault of vision could produce this constant error, as with any procedure of doubling, or reading angles, such an error should compensate. Suppose that the plates are set incorrectly to zero at the start, the same error in reading the final angle would eliminate the first, thus giving a true result.

I believe the mental and optical process of setting two plates to zero, for which case the vernier and plate graduations are symmetrical, is different from reading an angle which has been turned. Possibly the eye is more relaxed in making the symmetrical setting, while an excess of concentration in the other case affects the accommodation of the eye.

Unfortunately, I have not had the opportunity to see if this theory might be proved by trying the effect of not setting the plates to zero. A method which I think originated with the U.S. Geodetic Survey, is to set the plates only once to zero, to start. After that, the upper plate is never reset, as the last reading of one angle is taken as the first reading of the next, simply making a subtraction in each case for the true angle.

This method is impracticable in certain kinds of work, such as running curves, on account of the complication in notes. I would be interested to know, however, if it does lead to more accurate results, for it seems to carry out more completely the "theory of reversals," which is the basis for all methods of eliminating instrumental errors, and which should be applied, if possible, to the human eye.

JEROME FEE, Assoc. M. Am. Soc. C.E.
Assistant Engineer, Pacific Gas and Electric Company

San Francisco, Calif.
April 27, 1931

Progress in Wind Bracing

DEAR SIR: In my opinion, the recommendations of the Structural Division's sub-committee, given in the March issue, are characterized by sound common sense and good judgment, and they certainly represent very closely the general trend of my own ideas and practice. I am entirely in accord with the first three recommendations given in the summary and also with the fifth, sixth, and eighth recommendations.

With regard to the fourth recommendation and the matter of distributing the wind load between the steel frame and the walls or partitions, I am somewhat inclined to treat buildings individually. We have just been designing a 23-story building for telephone operation purposes, where we are strictly in accord with this recommendation to the extent that partitions, where present, are temporary and can offer no reliable assistance in withstanding load or distortion from wind forces.

Concerning the seventh recommendation, there is no doubt that observations as to the lateral deflection of tall buildings would assist materially in checking the actual results of construction against theoretical assumptions and calculations. Wherever practicable, the carrying-out of such observations should certainly be encouraged and the general data distributed to the practicing members of the profession. I feel that engineers are now devoting a great deal of attention to the question and that, for this reason, the general practice is improving. Architects are also looking somewhat more sympathetically upon the demands for space in which to achieve the required rigidity of structural framework, and I am quite satisfied that the circulation of such well considered opinions as are included in the recommendations, will be conducive to a fuller appreciation and understanding of the problem.

P. L. PRATLEY
Monsarrat and Pratley, Consulting Engineers
Montreal, Quebec
April 23, 1931

Calculating Wind Velocity

DEAR SIR: I have read with much interest C. K. Young's report on "Wind Bracing in Tall Steel Buildings," in the March issue, and should like to take this opportunity to discuss some of the questions raised in it.

Obtaining the velocity at heights from surface conditions is an extremely difficult one, whereas the probable mean gust velocity that may be expected for a mean hourly velocity can be quite accurately obtained by G. C. Simpson's formula. This formula, however, does not give the extreme gust velocity that may occur, which should be considered in connection with the problem of wind bracing. Thus, possible extreme gust velocity is given by the equation:

$$V_g = 3 + 1.64\ Vm,$$

when V_g is the gust velocity and Vm the mean hourly velocity. (Patterson, *Transactions of the Royal Society of Canada*, Vol. 13, 1919.)

These equations are for obtaining the gust velocity near the surface. Before they can be applied to any of the formulas used to calculate the wind velocity at heights from surface conditions, it is necessary to know how the amplitude of the gusts diminishes with height, especially where there are other high buildings offering obstructions in the vicinity. So it is very doubtful if the highest gust velocity could be used as the basis for obtaining the possible highest wind in different elevations above the surface.

Another important factor in considering the various equations that have been devised for obtaining the velocity up to a considerable height is the fact of change of direction on the velocity with height. Winds that change through large angles with height also experience a large change in velocity—frequently a decrease. No matter what formula is used in estimating the velocity at heights, these factors have to be considered. I believe that the gradient velocity, as stated by Professor Marvin, will give the most accurate estimation of wind velocity at about 1,500 ft. These velocities can be obtained from the weather maps for any place over a long period.

No consideration has been given in Mr. Young's report to the line squall. In many places, these winds may be the most violent experienced and also show the greatest gustiness. Their onset is also extremely sudden. It is a question whether their velocity would increase with height or be changed into a vertical velocity. This is a subject that ought to be investigated, and the tall buildings that are now available for the investigation should give very valuable results.

J. PATTERSON
Director, Department of Marine Meteorological Service of Canada
Toronto 5, Ont.
April 29, 1931

Maximum Wind Pressures Vary Greatly

SIR: Referring to the progress report of the Sub-Committee on Wind Bracing in Steel Buildings, published in the March issue of CIVIL ENGINEERING, I should like to bring forward the following points.

In regard to the first recommendation, it seems that any attempt to prescribe the wind force to be assumed in design should also take into account the geographic location of the building. The following tabular form shows the maximum wind velocity recorded in some representative areas of the United States:

PLACE	MAXIMUM RECORDED VELOCITY (MILES PER HOUR)
Boston	72
New York	96
Atlanta	66
Miami	128
Chicago	84
Pittsburgh	70
Nashville	75
Galveston	93
Denver	75
Helena	70
Spokane	52
San Francisco	64

With such a variation, it seems unjustifiable to define one design pressure for the entire country. Since it is not specified what locality the sub-committee had in mind when drafting the report, I assume that the recommendation is intended to provide for the maximum conditions that may exist anywhere within the United States. However, there has been calculated, in several instances, the pressure which must have been exerted to cause certain observed failures.

After the St. Louis tornado of 1896, Julius Baier calculated the pressures necessary to cause the failure of various portions of the east approach of the St. Louis Bridge as 58.2, 44.8, and 64.9 lb. per sq. ft. He also calculated the pressure required to cause the failure of a cylindrical brick chimney as 79.0 lb. per sq. ft. The committee reporting on the Central Illinois tornado of 1925 computed the probable wind pressure necessary to cause the failure of an elevated water tank as 110 lb. per sq. ft. In the face of such data, is the sub-committee's recommended value of 20 lb. per sq. ft. justified?

Design pressures of the order recommended in this report are usually reconciled with theoretical and observed values by the theory that the average pressure on the whole is considerably less than the pressure at a point. What, then, of the experiments conducted some years ago on the high level footways of the Tower Bridge in London by Thomas E. Stanton, of the National Physical Society of London? The results of this rather elaborate series of pressure observations led him to conclude (*Proceedings*, Institution of Civil Engineers, Vol. 219) that "the pressure over the whole area is sensibly equal to that at a point in it," and that "no reduction in the wind pressure factor, on account of the lateral variation of wind speed, could be justified."

The sub-committee's interpretation of the results of S. P. Wing's investigation of the variation of pressure with height, as embodied in the curves of Fig. 1, seems hardly to accord with his original discussion of his experiments (*The Electrician*, July 1, 1921) in which Mr. Wing reduced his velocity-height formula, as published in the sub-committee's report, to a much simpler straight-line relation between the pressure and the height. According to Mr. Wing, the pressure, P, at any elevation up to that at which the gradient wind is reached, can be obtained with an error of not more than 15 per cent by the formula,

$$P = (0.00126h + 1.16)P_g$$

where h is the height above the ground surface in feet, and P_g is the pressure at the ground surface. Note that the formula has the ground conditions as its basis, not the assumed conditions at an elevation of 500 ft. By this formula the pressure will double at a height of about 670 ft. This seems a radical departure from the common opinion on this subject, and I feel that it is probably excessively severe. On the other hand, I also feel that Mr. Wing's observations furnish the best available experimental data on the subject and should be duly regarded as such, a viewpoint which seems to be shared by Robins Fleming (*Wind Stresses in Buildings*, page 42).

Probably no sane engineer would design steel on the basis of a metallurgist's prediction of what the elastic limit would be, when tests, however meager, indicate it to be only half that predicted. However, in the face of such data as those referred to, the assumption that wind pressures of the order recommended by the sub-committee represent the maximum likely to obtain in this country, seems a somewhat analogous procedure.

Concerning the second recommendation, it would seem more reasonable to express the overturning effect in terms of the column reactions, as suggested by Albert Smith.

At the present time, I feel that about the most definite conclusion that can be drawn concerning the fourth and fifth recommendations is that, in considering the strength of the steel frame, it is unsafe to assume any additional strength from the masonry, but, in calculating the rigidities of the exterior bents, it is unreasonable not to do so. In my opinion, the solution of this problem, as well as most of the other questions involved in wind bracing design, lies in the extensive application of the seventh recommendation.

ROLLAND A. PHILLBO, Jun. M. Am. Soc. C.E.
United Engineers and Contructors, Inc.
Philadelphia, Pa.
April 23, 1931

Design of Gravity-Type Dams

TO THE EDITOR: In his article in the April issue, Mr. Grunsky does well to point to the importance of cooling the concrete in large structures. Some years ago, Fredrik Vogt, Assoc. M. Am. Soc. C.E., suggested to the engineers of the U.S. Reclamation Service a method of cooling a gravity dam by means of pipes which, I understand, has been adopted for the Hoover Dam.

About two years ago, I was shown a design quite similar to the one now proposed by Mr. Grunsky. In this design the compartments were to be filled with earth. This seems to me to be safer than water which, especially in case of an earthquake shock, might make trouble.

It is a very complicated problem to determine the stresses in a structure such as the one proposed. Ordinary methods appear to be wholly inadequate, but a complicated stress distribution is, of course, no valid argument against an otherwise desirable structure.

As Mr. Grunsky points out, authorities are not agreed as to whether the safety of a gravity dam is increased or decreased by arching. Nor are they agreed as to whether the fact that a radial element is thinner at its downstream face than at its upstream face should be taken into account. However, there can be no difference of opinion about which of the various assumptions will lead to the safer design, and these are the assumptions that a careful engineer will accept for his design.

It seems to me that Mr. Grunksy's design should be given careful study, and it is not improbable that the classical gravity-type dam will undergo some fundamental changes in the near future.

B. F. JAKOBSEN, M. Am. Soc. C.E.
Consulting Engineer
Los Angeles, Calif.
April 27, 1931

Architecture and Engineering

EDITOR: The article by Mr. Spurr on the "Bank of Manhattan Company Building," in the March issue, presents an important service to the profession and the Society. Even in building problems which can be completely solved by the method described by Mr. Spurr in his book on *Wind Bracing*, there are many points which have to be settled by reasoning much less clear-cut than that employed in large bridge design. Where, as in the Bank of Manhattan Company Building, architectural requirements make the best development of that method impossible, the gain for the profession in being permitted to examine the solution of the problem, and the processes of solution, is very great.

All engineers will probably agree with the statement in Mr. Spurr's book that, in planning a building 120 stories high, "The requirements of the structural layout should have first place." Architects generally recognize that size of columns, depth of trusses, and other questions involving the force of gravity and elastic action,

must be referred to the engineer's opinion, and that that opinion must rule, even though the architectural expression suffers in consequence. The architect must also be made to see that tall buildings are immense cantilevers, carrying a tremendous human freight, and that he should build up in his mind the same respect for wind loads that he already has for gravity loads.

A building which has a visible inclination, whose partitions frequently crack in an unsightly manner, or whose vibration is unpleasantly noticeable, is so depreciated that immense financial loss is incurred. Consequently, the engineer ought not to allow the desire of the architect or the owner, in order to save a little space, to restrict him to $4^1/_2$ in. in which to contrive a compression member as vital to the security of the building as is the wind strut between Columns 81, 80, and 79, in the Bank of Manhattan Building.

To have carried through the design of this building at such speed, while the architectural working drawings were being developed, is a remarkable achievement for the chief engineer and his staff. It does not take long to tell about it, but engineers who read between the lines realize the intelligent and faithful labor required to produce a design under such conditions.

Certainly Mr. Spurr has proved his point—that diagonals between beams are cheaper than wind brackets between columns and beams, and very much stiffer. Undoubtedly the inner corner of a very large wind bracket is, to some extent, wasted. There are, however, some losses in a system which uses complete trusses, or beam-to-beam diagonals in place of wind brackets.

Diagonals one bay long must share with the beams the deformation caused by the shortening of the columns. In the case of the two-panel Warren truss, the diagonals must receive an indeterminate, but possibly very large, compression due to the shortening of the columns. It is not correct to assign to them only the floor and partition load of one-half bay.

Where beam-to-beam diagonals are used, the beams, being very much stiffer than for two-panel Warren bracing, will also contribute a large load to the diagonals, due to their resistance to bending.

Unless the rivets in the column-to-beam diagonals and in the I-beam lug connections are considerably understressed, the slip of rivets will upset the stiffness relations between those bays and the ones with long diagonals.

The design and construction of the foundations of the Bank of Manhattan Company Building was a brilliant piece of work. The cost of driving the temporary caissons before the site was cleared must have been saved several times in occupancy value and in interest. In Fig. 3 of Mr. Spurr's paper are shown footings carried through disintegrated rock. One of these lies only 13 ft. and 16 ft. from the adjacent columns in the same line, whose footings stopped 8 ft. higher. These were apparently narrow pockets, and I am interested to know if there were more than two, and if such pockets are found often in New York rock.

There is one wind and temperature effect which, in buildings of this height, might cause great expense in repairs and might entail some structural damage. I have not seen it alluded to in the descriptions of the new high buildings in New York. A strong quartering wind with low temperature will tend to shorten the corner column of a tower much more than it shortens the intermediate wall columns. In 500 ft., a drop of 20 deg. would cause a difference of length of $^3/_4$ in., which would certainly cause much damage in the higher stories. In one case on record damage has been done at much smaller heights. The insulation of the corner columns might be expensive, but it is certainly quite worth while.

ALBERT SMITH, M. Am. Soc. C.E.
Smith and Brown, Engineers, Inc.
Chicago, Ill.
May 2, 1931

Economics Not Sole Consideration

TO THE EDITOR: As Mr. Cutler pointed out in the January issue and as I have frequently stated, there is something more to the selection or location of state or county highway systems than the mere economics of transportation costs. There is a social side which the engineer has, in his public discussion at least, neglected to too great an extent. Consequently, social considerations have been left to the politician.

As long as the engineer discusses and proposes the location of public highways on a purely cost-of-transportation basis, so long will the politician interfere with his authority.

The Federal Government has recently built a wonderful bridge across the Colorado River above the Grand Canyon near what is known as Lee's Ferry. This bridge is a link in a route across the Painted Desert between the Mexican line and the Canadian line by way of Phoenix, Ariz., and Salt Lake City. There is no other north and south route practicable for several hundred miles on either side.

It is possible to travel for many miles along sections of the Lee's Ferry route without seeing a habitation of any kind. There is no local traffic from Flagstaff, Ariz., up into the State of Utah, except that of the Indian on his pony. In view of this fact, it is impossible to claim that local transportation has been saved by the construction of the Lee's Ferry route, but this route is important. It is a route which a great many people from outside the locality are now taking and which a great many more will take. This is a good illustration of the importance of certain connections between local systems, built and designed for local use, and outside localities.

For recreation, the population of the country is more and more turning to travel on the highways. Unless this factor in highway location and construction is considered and the county systems are linked up with each other, even though there is no inter-county commerce to provide for, highway development will be retarded, in such respects, for instance, as that of the international system, now being considered between Alaska and South America.

W. W. CROSBY, M. Am. Soc. C.E.
Consulting Engineer
Coronado, Calif.
May 2, 1931

The Value of Aerial Photographs

DEAR SIR: The article by Colonel Birdseye on the "Photographic Surveys of Hoover Dam Site," which appeared in the April issue, is of importance to all who are interested in the use of stereoscopic mapping instruments.

Of course, the case presented by the Hoover Dam survey is a special one. Under conditions such as these, in which the important areas are often more vertical than horizontal, it is to be expected that the photo-theodiolite will replace the aerial camera. It is probable,

however, that in the United States a majority of the work accomplished by means of stereoscopic plotting instruments will fall in the province of aero-photogrammetry. In territory which is inaccessible or difficult for field parties, or in which only meager control can be provided, the use of instruments, such as the aerocartograph, in conjunction with vertical aerial photographs, will unquestionably be found to present advantages not obtainable by any other method of mapping.

The outstanding characteristic of the aerial photograph is that of versatility. Its usefulness extends from the reconnaissance of large areas through the intermediate steps of photographic mosaics or pictures of the ground, and line-drawn maps without accurate topography, down finally to accurate topographic maps prepared wholly by means of steroscopic instruments.

It is certain that, as the study of the economics of mapping is given greater attention, the advantages of the use of aerial photographs in conjunction with such precision instruments as the aerocartograph will become more and more evident.

BRUCE C. HILL
Captain, Corps of Engineers
U.S. Army

San Francisco, Calif.
April 28, 1931

Greater Variability in Concrete Than in Cement

TO THE EDITOR: I read with keen appreciation Mr. Merriman's paper, "Logic in Engineering Diagnosis," in the April issue, and concur fully with the abstract phases of his critical analysis of the engineer's mental processes. However, it may prove to be somewhat difficult to follow the logic of his argument in the case of cement, which is chosen for its specific application.

Having pointed out that cement, from the nature of the manufacturing process, must be a variable material, Mr. Merriman offers in proof of this variability of cement, evidence which appears to involve not only cement but numerous other variables as well. The fact that disintegrated concrete is highly unsatisfactory is admitted by everyone, but why select one possible cause of concrete disintegration to the exclusion of all other possible causes and attach to it all the blame?

Concrete is the product of a manufacturing process just as is cement. Both processes may be very carefully, and equally well, controlled. Although this may be so, it is altogether probable that such equality is ordinarily wholly non-existent. Also, in the process of proportioning, mixing, transporting, placing, and curing which results in concrete, there occur more variations than in the manufacture of cement, with a consequent greater variability in the concrete than in the cement.

Recognition of this fact does not by any means establish and demonstrate uniform and satisfactory quality in the cement, but it does lead to the conclusion that improvement in the quality of concrete may involve more than the cement alone. To prove, by the disintegration of concrete, a deficiency in the quality of the cement, requires the prior elimination of all other variables.

Consider Mr. Merriman's statement that cement may "logically" be at fault. This is apparently true of the porous, permeable structure of the blocks. The disintegrated channel floor, with the enduring patches shown in the photograph, may demonstrate the variable quality of cement but, on the other hand, it may demonstrate that different results can be expected with different mixtures. The wall built 20 years ago is weatherbeaten and disintegrated in the view shown of it. It may prove a deficiency in the quality of the cement used, yet excess water and the phenomenon of water-gain may also explain the trouble. If the quality of the cement is at fault, why should the disintegration here shown, as in so many cases reported by observers, be at the top of the pour?

There are the other possible causes of disintegration which suggest themselves as one views the illustrations and reads their captions. Until these causes are eliminated, it scarcely appears logical to conclude definitely that the cement used was of inferior quality. However, these comments are offered, not in championship of the cement, but solely in response to the urge and constraint of "the relentless requirements of rationalism."

W. F. WAY, M. Am. Soc. C.E.
Construction Engineer
Henry and McFee Contracting Company

Seattle, Wash.
April 22, 1931

Uncontrolled Water Content Produces Laitance

EDITOR: I wish to take issue with one of the points in Mr. Merriman's article on "Logic in Engineering Diagnosis," in the April issue. He states that, "During the past 15 years various slogans have had their day . . . . Then came . . . . the 'slump test'; and now we are in the era of the 'flow table' . . . ." The fact that all of these phrases came into use at practically the same time—from 1917 to 1920—and that those heard at present have been continuously before concrete engineers since that period, is perhaps of little importance, but it seems to me that the paragraph containing the phrases quoted is an example of illogical reasoning.

Engineers familiar with the production of concrete are generally aware that the adoption of the flow table and slump cone have permitted the measurement and control of one of the important variables in concrete making, that of consistency—a factor which was ignored in early concrete specifications. No doubt there is evidence to indicate that some concrete failures have been due to quality of the cement, but it is probably fair to say that bad cement has resulted in the production of an insignificant yardage of inferior concrete as compared with the use of excess mixing water and the lack of attention to "water gain," where considerable depths of fresh concrete are placed in a short period of time.

Laitance can be produced with any portland cement if water content is uncontrolled. Intelligent use of the slump cone or flow table aids in holding consistency to the minimum that will make placeable concrete, and reduces the tendency to form laitance. To condemn these tests which, when properly applied, can be of great assistance in minimizing the type of failure which the author attributes to inferior cement, and to label them as passing "slogans" seems to be an outstanding example of illogical reasoning on the part of the engineer.

G. M. WILLIAMS, M. Am. Soc. C.E.
Professor of Civil Engineering
University of Saskatchewan

Saskatoon, Sask.
April 24, 1931

Concrete Masonry at the Toe of an Overflow Dam

TO THE EDITOR: The question that occurred to me when I read Mr. Ewald's interesting article in the March issue, was whether the conditions resulting from erosion below the spillway dam were considered serious by his company or by those responsible for these works.

The cross sections, shown in the figures, indicate considerable erosion in places at the downstream toe of the dam, and I am interested in learning just how, and to what extent, remedial measures, if deemed necessary, would be undertaken. A more extensive toe protection, built of concrete downstream from the present limits of the structure, might have been advisable in the original construction of the dam. It may be argued that the masonry thus placed might have proved merely a substitute, equal or perhaps inferior to the comparatively sound rock, and would have suffered accordingly.

Nevertheless, the mixing and placing of such concrete at the toe would have been under complete control. Thus a uniform, smooth, hard surface, to lead the flow farther from the foot of the structure, seems preferable in this case to the natural rock which, at best, is variable in character, texture, and quality of resistance—especially when it is in such close proximity to the toe of a dam.

ORRIN L. BRODIE, M. Am. Soc. C.E.
Designing Engineer
Board of Water Supply

New York, N.Y.
April 26, 1931

Should College Degrees Be Professional?

TO THE EDITOR: Although I was much interested in Professor Wickenden's article on "The Professional Status of the Engineer," in the October issue, I was unfortunately prevented at the time from submitting a discussion. Therefore, at this late date, I am venturing to express my views on the subject.

Certification as a solution is the keynote of Professor Wickenden's article. The after-college self-education of the engineer determines the vital aspects of his career and must establish his future standing in the profession. College degrees, therefore, should not be professional in character; they should be awarded when the young engineer has earned the right to certification in his profession. Here is an opportunity for national engineering societies, which have rigid entrance requirements, to cooperate with technical schools in establishing that standard of professional practice and knowledge of engineering science which would justify a professional degree.

There is a present-day tendency for those in ultra-collegiate circles to favor strictly cultural subjects and to get away from what they term a bread-and-butter training. It is of more importance, from their point of view, to know the five Latin declensions than to know that the anopheles mosquito is a disease-bearing insect, and that there are practical means of robbing it of its destructive power.

It must be remembered, also, that the word culture is derived from the Latin "cultura," meaning cultivation or tillage. What training is best for the systematic improvement and refinement of the mind?

> Who shall decide, when Doctors disagree
> And soundest casuists doubt, like you and me.

However, this problem is too closely connected with the professional activities of every engineer to be regarded as a non-essential.

ALONZO J. HAMMOND, M. Am. Soc. C.E.
Consulting Engineer

Chicago, Ill.
May 1, 1931

Costs of Twelve-Month Construction Not Excessive

DEAR SIR: The paper by Mr. Taylor on "Twelve-Month Construction," published in the January issue, recalls to me my first experience with year-round construction, which was in connection with track-elevation work in Chicago in 1892. In order to have tracks laid prior to the opening of the World's Fair, it was necessary to work through the winter. There was considerable feeling on the part of the men against this, so the railroad company's field engineer and I, representing the steel contractors, set an example by appearing on the job ourselves. Dressed very warmly for the occasion, we would walk down the track in utter disregard of the below-zero temperature. Soon the men began to work and, once started, things progressed satisfactorily.

Although winter construction is not the most economical method, we have found it necessary for a number of projects. In recent years, we have erected several bridges in Alaska—a 700-ft. and a 500-ft. simple span, and a 384-ft. arch span. The arch span, which is 380 ft. above the stream level, was erected by the cantilever method. The setting of the falsework for the simple spans was very difficult on account of the deep and turbulent streams. Yet this difficult construction work was performed in the winter months when the thermometer was as low as 30 deg. below zero.

During the post-war period, which was a time of labor shortage and high interest and commission rates, it was found desirable to complete structures with the least possible delay in order to secure prompt returns on the investment, particularly in the case of large office buildings. Nor were the costs excessive. In fact, the cost of work done in the winter, compared with construction during temperate weather, is, relatively speaking, a small part of the total cost of the structure. The steel shell of a building usually costs, I think, from 30 to 35 per cent of the total cost and, in the case of large office buildings, as low as from 10 to 12 per cent. Increased costs are incurred practically only in the erection; and if erection is done in the winter, it actually results in an advantage, as it permits the other trades to start in the spring during nice weather.

ALBERT F. REICHMANN, M. Am. Soc. C.E.
Assistant Chief Engineer
American Bridge Company

Chicago, Ill.
May 9, 1931

SOCIETY AFFAIRS

Official and Semi-Official

Westward Ho!

The date fixed for the Tacoma Meeting, July 8–10, 1931, permits the happy opportunity for eastern members and their friends to celebrate the Fourth of July together in famous Glacier National Park. Plans call for members of the group to leave Chicago on July 1 and to arrive in Glacier National Park on July 3. While in the Park they will stay at Many Glacier Hotel in the heart of Glacier Park, surrounded with beautiful mountain scenery where relaxation, sightseeing, hiking, or boating will be in order, as desired.

MT. GOULD AND MANY GLACIER HOTEL
Glacier National Park

Those who wish also to make up a group visiting Yellowstone National Park for a four and one-half day tour may do so by assembling at Cody, Wyo., on June 28, later joining the others in Glacier National Park on July 3.

Leaving Glacier National Park about midday on July 5 the group will arrive in Tacoma on the morning of July 6, and go directly by special bus to Paradise Inn, Rainier National Park. The stay there will terminate Tuesday evening, when they will return to Tacoma for the Annual Convention of the Society, which will open on Wednesday, July 8, at the Hotel Winthrop.

The trip, arranged through the assistance of the Passenger Department of the Great Northern Railway may be made on the all-expense plan. As an indication of its cost, on the basis of a lower berth, one may count on $185.30 for all expenses from Chicago to Glacier National Park, Paradise Inn, and up to the moment of arrival at Tacoma for the Convention, and also railroad fare for the return trip to Chicago by a direct route. Hotel and other expenses during the Convention, as well as Pullman fares and meals for the return trip are not included. The addition of a visit to Yellowstone or of an Alaskan cruise would cost more as would also travel from cities to the east of Chicago, or return by the less direct routes.

After the close of the Convention, members would be free to take advantage of such sightseeing as they might wish—trips to Alaska or California, visits to interesting points on the Pacific Northwest, and return by any of the convenient transcontinental routes.

Although the Society is taking no responsibility for the management of this trip, it has cooperated in the preliminary arrangements to secure the most attractive itinerary. It also is endorsing the plan and the auspices under which it is being carried out. Requests for detailed information may be made to M. M. Hubbert, General Eastern Passenger Agent, Great Northern Railway, New York, N.Y.

Creditable Attendance at Norfolk

All reports point to the fact that the Norfolk Meeting was most successful. However, the success of such meetings cannot be measured entirely in terms of the numbers present. There is the further thought that service is rendered to those who otherwise would not find it practicable to attend a Society meeting for one or another of many reasons.

The sessions at Norfolk were lively, interesting, and profitable in their technical aspects. This may be concluded from a consideration of the various technical papers, which are abstracted in this number. The members and guests who helped to contribute to this result were distributed somewhat as follows:

Total Attendance	500
General Session	375
Technical Division Sessions (Simultaneous)	
Surveying and Mapping	90
Highway	50
Waterways	40
Sanitary Engineering	50
Social Events	
Ladies' Drive	100
Wednesday Dinner and Dance	240
Thursday Boat Trip	280
Thursday Informal Dinner	200
Friday Bus Trip	150
Student Chapter Conference	75

Social features and historical excursions were also very generally attended, affording information, relaxation, and an opportunity for the extension of acquaintanceship. It is these portions of the program which evidence most, perhaps, the long and faithful work on the part of the local members and committees who plan and labor hard for this success.

The number in attendance at the Student Chapter Conference is noteworthy. Ten engineering schools sent a total of 54 students as delegates. In addition, there was a generous number of Society officers and other interested individuals. A brief note on this particular meeting is found elsewhere in this issue.

To the Local Committee which made this successful meeting possible should go a large part of the credit. This faithful committee worked under the leadership of an Executive Committee with the following personnel: Frank L. Nicholson, Chairman; Wilson T. Howe, Treasurer; George M. Parker, Secretary; Lyle F. Bellinger, William D. Faucette, Henning Fernstrom, Ferdinand F. Harrington, Edgar M. Hastings, G. Hubard Massey, Thomas W. Roby, Reuben R. Schweitzer, Walter H. Taylor, 3rd, and Gordon R. Young.

Metropolitan Section

What might appear to be a new Local Section will hereafter be found in the roster of Society organizations. In reality, it is an old friend under a new name. By action of the Board of Direction at its Norfolk Meeting, the request of the New York Section to change its name to the "Metropolitan Section" was approved. Under such a designation it will hereafter be known.

Aboard for Tacoma

From an engineering standpoint, Puget Sound presents the absorbing spectacle of technical experts aiding an energetic people to build modern cities, to erect great power plants, and to fashion distinctive industries. And yet so much of the atmosphere of the virgin wilderness still clings about this Northwest country that the coming Summer Convention of the American Society of Civil Engineers in Tacoma, from July 8 to 10, carries with it the lure of a vacation in the great open spaces, as well as contact with fellow members of the profession, and the opportunity to hear instructive papers on engineering subjects.

Fully alive to the unusual opportunities for recreation which its environs offer the engineer who has never lived in the Pacific Northwest, the Tacoma Section has seen to it that the program includes some of the characteristic recreation features of the country. Both visiting engineers and their wives will find themselves lured away to where the blue waters of an inland sea lap the green shores of enchanting islands, or where the firs of majestic virgin forests tower into the sky.

Technical features of the interesting program will be marked by a consideration of the problems particularly fitting to the development of the Northwest. These topics will be augmented by whole sessions devoted to meetings of a half-dozen Technical Divisions; not forgetting also the President's Annual Address, always scheduled for the occasion of the Convention. Particular subjects and speakers need not be singled out for mention here. Suffice it to say that the official program, shortly to be released, will disclose a well rounded plan of Meeting activities.

On Wednesday evening, after a day almost entirely devoted to the serious business of the Convention, will come an outing at Point Defiance Park, occupying a square mile at the tip of the peninsula on which Tacoma lies. Here, a typical shore dinner will be served among delightful surroundings, with dancing to follow.

One whole day, Friday, July 10, has been assigned for an excursion on Puget Sound. Undoubtedly, this is one of the most beautiful bodies of water in the world, extending as it does into the very heart of Washington State, with countless indentations, inlets, coves, and passages, dotted with beautiful islands. Every foot of its more than 2,000 miles of shore line is an invitation to pitch a tent, to fish, and to live.

This trip will proceed from Tacoma harbor past Vashon and Maury islands for a short visit to the Puget Sound Navy Yard at Bremerton, located in a charming bay; thence by a new channel past Bainbridge Island to the ship canal leading to Lake Washington. Between this lake and Puget Sound lies Seattle. Luncheon will be served on board. After a trip about the lake, the return will be made to Tacoma, another 40 miles of scenic voyage. On this trip into Lake Washington, the Aurora Avenue Bridge, now under construction, will be seen, and near Tacoma the boat passes under the Cushman Power line, which crosses the narrows with a 6,244-ft. span.

For those who can stay, Saturday will be devoted to an all-day inspection trip to the Cushman Power Development of the City of Tacoma, the second unit of which has just been completed. The 75 miles of the trip by auto, each way, will itself be a revelation of beauty, passing through the state capital with its magnificent new buildings. The power development will be of absorbing interest in its various engineering problems.

During odd hours of the convention, a short trip may be taken to the site of old Fort Nisqually, a historic Hudson Bay Company trading post, where the oldest building in the state still stands. Lakes, for all the aquatic sports, abound in easy reach. A half-dozen private and public golf links are convenient.

Ladies at the convention will be entertained on Wednesday, the opening day, with a bridge tea in delightful surroundings. Later, an inspection of the gardens of Ashton Hill, home of General and Mrs. James M. Ashton, will be made.

On Thursday, a visit will be paid to Haddaway Hall, the residence of Mr. and Mrs. J. P. Weyerhaeuser, whose gardens are also noteworthy, and from which views of Mount Rainier and the Olympic mountains are obtained. After luncheon the tour will extend to the gardens of the exclusive lake residential district some ten miles distant, including Thornwood, one of the most beautiful residential grounds in the country, and Dowerdell, a more rustic estate of great charm.

Other fascinating trips to nearby points abound. No stay in Tacoma by distant visitors would be complete without a ride to the famous Rainier National Park, 60 miles away. Here, at Paradise Inn, over a mile above the sea, winter unites with summer, snow with flowers. And for those who can climb, another mile and a quarter of ascent challenges the mountaineer.

The committee assures every member that a cordial welcome awaits him in Tacoma.

Warning to Our Members

Many plausible schemes are continually being tried to catch the unsuspecting. Engineers themselves are not free from the dangers incident to such unethical practices. A case in point has just been brought to light, in which luckily no harm was done, thanks to the efforts of several members.

Recently, one Earl R. Becker, said to be a licensed architect in the States of New York and New Jersey, approached certain engineers. According to his story, his principal in the proposed transaction, whose name he was not at liberty to disclose, wished to secure the immediate employment of a very capable engineer, or engineers familiar with waterways. Accordingly, Becker was brought into touch with a member of the Society through the agency of the Engineering Societies Employment Service and negotiations went forward.

The member's suspicions were soon aroused by the nature of Becker's statements and the character of the agreement which he was endeavoring to negotiate on behalf of one Alfred L. Cameron. His suspicions were confirmed by a member of the staff at Headquarters, to whom Becker made overtures to secure, in addition, an engineer suitable to fill the responsible consulting position on a mammoth engineering project which was already well under way. The very nature of this latter "opening" and the known auspices under which the project was going forward made the suggestion dubious. One suspicious element of the entire matter was the purported political influence which was claimed on behalf of the unknown principal.

Investigation disclosed that Cameron resides in Brooklyn, N.Y., and claims to be an attorney at law. It further appeared that he had no such openings for technical men.

Members of the Society are advised to beware of entering into any negotiations on such a proposition, and, if approached, to bring the matter to the attention of Society officers at Headquarters.

Committee on Weather Data

Important results are expected from the recent appointment of a Committee on Weather Data as authorized by the Board of Direction at its January meeting. The study of this active question results from many efforts on the part of members throughout the country, but particularly on the Pacific Coast. Basically, the attempt is being made to see in how far the weather records can be made more valuable to civil engineers in the fields of water supply, irrigation, reclamation, and other similar subjects.

Some engineers feel that present data are subject to some uncertainty. For example, they desire to know just how reports on meteorological matters from volunteer observers are calibrated for uniformity of results. Other questions are raised as to the effect of the positions of the temperature-, wind-, and rain-measuring instruments, so that the proper reduction of the given data may be made for conditions on the ground.

All these questions have been referred to a definite committee composed of Donald M. Baker, Chairman; and Raymond A. Hill, J. B. Lippincott, Charles H. Lee, and F. H. Newell, Members Am. Soc. C.E. Presumably, this committee will find it advisable to function primarily in an administrative capacity, seeking assistance of interested members, resident throughout the United States. It is hoped that these many correspondents will, in turn, be of great value in collecting data and in commenting on local observations as they find them of significance in their own work. Suggestions to this end will be gratefully received by the committee.

New Student Chapter Authorized

By action of the Board of Direction at Norfolk, on April 13, the application of the Newark College of Engineering to be granted a Student Chapter charter was approved. This extends the present list of Chapters at approved institutions to 98. As a result, all the states but five are now represented by at least one Student Chapter.

On May 6, Charles A. Mead, M. Am. Soc. C.E., Director, District No. 1, installed the new Chapter and outlined to student members the advantages to be derived by reason of the new organization. The faculty sponsor of this latest Student Chapter is Prof. H. N. Cummings, Assoc. M. Am. Soc. C.E. This group of student members is both welcomed and congratulated upon attaining the required high standing. They have elected John Stelger president, and Carl H. Huebner secretary of the organization.

Student Chapter Conference at Norfolk

The reputation for interest and profit which has been earned by the Student Chapter Conferences did not suffer as a result of the session at Norfolk, Va., April 15, 1931. The Committee on Student Chapters sponsors these gatherings at the time of the Spring and Fall Meetings of the Society. The entire committee was present to greet the 54 representatives from the following ten Chapters:

Alabama Polytechnic Institute
Catholic University of America
Clemson Agricultural and Mechanical College
Johns Hopkins University
University of Georgia
University of Illinois
University of Virginia
Virginia Military Institute (92 per cent of the Chapter)
Virginia Polytechnic Institute
Washington and Lee University

Various members of the committee were introduced and then President Stuart spoke briefly on the fundamental characteristics which a young engineer should possess. Secretary Seabury outlined the policies of the Student Chapter Committee and the various services available to the Chapters.

All the Chapters were represented by spokesmen, whose reports were characterized by ease of manner, clarity of presentation, and frankness of opinion, contributing greatly to the value of the conference.

In discussion, it developed that most Chapters admit to membership all civil engineering students in good standing in the three upper classes, and invite interested Freshmen to sit in. A few Chapters vary this practice by restricting membership to men of high scholastic standing or to the members of only the two upper classes.

Twice a month seems to be the most popular frequency for meetings. The larger Chapters are not always able to enjoy the intimacy possible in small groups, and therefore they find talks by outside engineers more profitable than the seminar type of meeting. The average-sized Chapters report good results from papers presented by students, based either on experience gained in summer practice or on special studies. Some Chapters utilize the regular seminar as the basis for their activities.

Many of the Chapters reported the usefulness of the Society's group of lantern lectures. Also, frank comments were made on the effectiveness of Faculty Sponsors, and interest was expressed in the newly created contact members of the Committee on Student Chapters. Inspiration and guidance rather than direction are most appreciated from these "elder statesmen."

In closing, Professor Doland, member of the Committee on Student Chapters, commended especially the value of Chapter participation in campus affairs, stating that "an inactive or indifferent Chapter is a distinct detriment to the institution in which it exists, and to the American Society of Civil Engineers. The hope of upbuilding the profession of civil engineering lies mainly in the well directed activities of the Society. The students present are the men who in twenty or thirty years will hold the reins and direct the destinies of the profession. Membership in Student Chapters affords a training for the better accomplishment of ideals which will form the basis of the future aims and objectives of the Society."

Taken by and large, this conference at Norfolk developed plenty of food for thought. Society and student representatives alike found much to take away with them for use in solving their own problems.

Proceedings in Review

As in the past, PROCEEDINGS will continue, for the time being, to be published in ten monthly issues during the year. This means that it will not appear in members' mail during June and July.

This summer-time pause creates a natural reviewing stand, particularly since it also marks the dead line for papers in TRANSACTIONS; that is, the papers that will appear in the forthcoming volume of TRANSACTIONS are discussed and closed, in general, between May 1930 and May 1931. Although a "cover comparison" with preceding years may indicate that recently PROCEEDINGS has reduced its capacity for presenting technical material, actually this is far from the truth. The material still appears, but in a different manner.

Society affairs, names of members, items of interest, Student Chapter activities, abstracts, and other material that formerly had to contest for space in PROCEEDINGS now receive ample consideration in CIVIL ENGINEERING. Since October, PROCEEDINGS has become what many engineers have longed for—an organ devoted primarily to the propagation and discussion of civil engineering subjects of a more technical nature, arranged so as to permit "getting at the meat of the subject" with the least possible loss of time.

Reviewing merely the past six months, some idea may be gained of the range of interest represented by the published papers and discussions. They have included, roughly, information on city planning, dams, drainage and irrigation, harbors, highways, hydrology, hydraulics, materials of construction, mathematics, rainfall, sewage disposal, structural engineering, surveying, transportation, tunnels, water power, and water works.

This material will be fittingly supplemented by a wealth of papers awaiting publication with the resumption of activity in August. In the meantime, the staff of PROCEEDINGS will be employed in preparing the annual volume of TRANSACTIONS, which may be expected to appear, as usual, in the fall.

Tangible Appreciation of the Late George S. Webster

In appreciation of the long and loyal work of the late George S. Webster, Past-President Am. Soc. C.E., not only for the Society at large but for its local interests, the Philadelphia Section adopted appropriate resolutions at its meeting on March 20, 1931. In addition to spreading these sentiments on its own records, it instructed that a copy be transmitted to Mrs. Webster, and this was done on behalf of the Section by Director Charles H. Stevens, on April 29. The copy presented to Mrs. Webster is beautifully engrossed in a form suitable for display, and was tendered as a tangible evidence of the esteem in which Mr. Webster was held by his close associates and warm friends in District 4.

Appointments of Society Representatives

HENRY M. WAITE, Vice-President Am. Soc. C.E., ARTHUR N. TALBOT, Past-President, Am. Soc. C.E., and M. S. KETCHUM, M. Am. Soc. C.E., have been appointed to represent the Society at the inauguration of Harry Woodburn Chase as President of the University of Illinois.

CHARLES B. BURDICK, M. Am. Soc. C.E., has been appointed one of the Society's representatives on the Washington Award which is administered under the auspices of the Western Society of Engineers.

FREDERICK H. FOWLER, Director, Am. Soc. C.E., has been appointed a member of the Society's Committee on Dams.

Progress of Registration in New York

Three bills relative to the registration of engineers were introduced in the recent New York State Legislature. One, amending the present Education Law (Engineers' License Law) had to do with the raising of the qualification requirements. This bill was passed and received the Governor's signature. The amendment reads in part as follows:

"For license as a professional engineer evidence must be submitted that the applicant:

1. Is more than 25 years of age;
2. Is a citizen of the United States or has legally declared his intention of becoming a citizen;
3. Is of good moral character;
4. Has satisfactorily completed a four-year high school course or the equivalent thereof approved by the department, and such further educational requirements as the department may determine;
5. Has had eight years or more of practical experience in professional engineering work of a grade and character satisfactory to the board;
6. Has successfully passed the prescribed examinations."

The requirements for a license as a land surveyor are similar except for Section 5, which requires that the applicant have had six years or more of practical experience in land surveying work of a grade and character satisfactory to the board.

The bill then continues:

"A person desiring such licenses shall make application therefor on prescribed forms.

"Examinations for certificate of license as professional engineer and as land surveyor shall be in writing and in English and shall be held by the department twice each year in at least three convenient places in the state. Subject to the approval of the department, the board shall determine the subjects of the examinations, and shall submit to the department each year lists of suitable questions for examination in the mathematical and physical sciences as applied to professional engineering and to land surveying, and the professional education and training required for the practice of professional engineering and of land surveying. Each written examination may be supplemented by such oral examination as the department shall determine upon recommendation of the board. The holding of serial examinations and granting of credits and the conditions of reexamination shall be determined by the department on the recommendation of the board. The plan, scope, and requirements of examinations shall, subject to the approval of the department, be set up and published annually.

"The department, on the recommendation of the board, may waive specific qualification requirements, except as to age, character, and citizenship, in the cases of applicants who are possessed of long established and recognized standing in the engineering profession, who have practiced lawfully for more than 12 years, or who were actively engaged in the practice of professional engineering or of land surveying in this state for at least 4 years prior to May 14, 1920, or who possess membership of a grade satisfactory to the board in a national engineering society recognized by the board as maintaining suitable standards of qualifications for membership.

"The board may exempt from examination an applicant who holds an unexpired certificate of license or registration to practice professional engineering or land surveying issued to him after examination by a legally constituted board of examiners in the District of Columbia or in any state or territory of the United States, or a certificate of qualification issued by the national council of state boards of engineering examiners, provided that the requirements for such certificate of license, or qualification certificate, or registration are of a standard not lower than those prescribed by this article.

"Prior to January 1, 1937, the board may exempt from all or any part of the examinations, a graduate of a college or school of engineering registered by the department as maintaining satisfactory standards. New York engineering colleges and schools and New York engineering students shall not be discriminated against by the registration of any college or school out of the state whose minimum graduation requirements are less than those fixed for New York engineering schools. Each complete year of study in such registered college or school of engineering may be accepted in lieu of one year of experience.

"Subsequent to January 1, 1937, before admission to examination, every applicant for a certificate of license as a professional engineer shall be required to submit, in meeting the educational requirement or such part thereof as the department may determine, evidence that he has graduated from a college or school of engineering registered by the department as maintaining satisfactory standards, and that prior to entrance to such school or college he has satisfied the prerequisites for admission thereto. In lieu of such graduation, an applicant may be admitted to the examinations upon presenting evidence of at least 12 years of practical experience in professional engineering work satisfactory to the board."

* * * *

A bill, in amendment to the same law, making provision for a revised definition of engineering, failed of passage. The proposed amendment read as follows:

"Professional engineering . . . shall be understood to mean the rational application of the principles of mathematics, the natural sciences, and economics, to the investigation, planning, design, development, construction and/or administration, of structures, machines, equipment, plants, processes, works, mills, mines, cities, highways, railways, waterways, harbors, water supply, sanitation, transportation, communication, power, heating, lighting, fire protection, ventilation, drainage, irrigation, flood control, airports, airways, municipal improvement, and/or other constructive works. . . .

"The term 'structures' . . . shall be understood to include all constructions having as essential features foundations, columns, girders, trusses, arches, and beams, any or all of these and/or other parts, in which safe design and construction require that loads and stresses be computed and the size and strength of parts be determined by mathematical calculation based upon scientific principles and engineering data; and shall include such structures as may be covered by the term 'buildings' as defined in any act in force in this state relating to the regulation of the practice of architecture.

"The use of the designation 'engineer' or 'engineering' with or without qualifying adjective on any sign, card, letter, letterhead, device, advertisement, listing, report, specification, plan, or drawing, or in any manner when such designation is intended to or may convey the impression that it signifies professional qualification, shall be considered as offering to practice professional engineering."

* * * *

The third bill consisted of an amendment to Section 300 of the so-called Multiple Dwelling Law, which now provides that plans for those structures falling within its scope may be filed only by the owner in person or a registered architect. This proposed amendment provided that plans might be filed by "the owner, or either a registered architect or a licensed professional engineer, experienced in the planning, designing, construction, or alteration of such dwellings, buildings, or structures."

This bill was passed by both Houses but failed to receive the signature of the Governor, his comment being that the bill was "loosely drawn." It had the endorsement of the Board of Direction. All three bills were introduced by Senator Thomas C. Desmond, M. Am. Soc. C.E.

Manual of Technical Division Procedure

With the expansion and the systematizing of the work of the Technical Divisions, it became advisable to codify the various regulations and recommendations adopted for operating the Divisions. Accordingly, about a year ago, a *Manual of Procedure* was formulated. This came about as a result of many meetings of the Technical Procedure Committee, in which the functions and relationships of Divisions, the research committees, and publication facilities of the Society were discussed and evaluated. This document assembles in convenient form a tremendous amount of authentic information regarding the administration of the technical features of Society work.

One of the first and most important results of the work of the Technical Procedure Committee was a code of technical procedure adopted in 1926 by the committee and amended only a year ago. This shows the explicit relationship of all the various technical efforts of the Society. Another portion of the Manual is devoted to the

duties of the Technical Divisions and their responsibility to the Board of Direction. A complete résumé of the desirable procedure for research work is also found. Further on, considerable material is given with regard to publications in which Divisions are interested, including Manuals, together with the procedure adopted for technical papers. Still other paragraphs refer to the administration of the Divisions, including personnel, meetings, programs, and finances.

All in all, there are few questions that refer to the administration of Technical Divisions that will not find an answer in this Manual. So great has been the demand for it that it became necessary to mimeograph an additional supply—copies being sent to members of the executive committees of Divisions and others who are interested. As long as the supply lasts, copies of this Manual will be furnished on request to Headquarters.

Rules for Rudolph Hering Medal Liberalized

At the instance of the Executive Committee of the Sanitary Engineering Division, the Board of Direction has recently approved a revision in the requirements incident to the award of the Rudolph Hering Medal. This medal was founded in 1924 by the Sanitary Engineering Division, to commemorate one of the notable figures in this branch of scientific endeavor.

Under the terms of the revision now adopted, "all original papers dealing with water works, sewerage works, drainage, refuse collection and disposal, or any branch of sanitary engineering, which are presented to the Society in finished form, whether presented to the Sanitary Engineering Division or otherwise, shall be open to the award, provided that such papers shall not have been previously contributed or published elsewhere."

Originally confined to authors of papers printed in TRANSACTIONS, the award is now broadened to include papers presented to the Society in any form or under any auspices, providing such papers are original. This does not necessarily involve publication by the Society nor presentation solely before the Sanitary Engineering Division.

Visits of Society Officers

Perhaps the most pleasurable duty of Society officials is that of establishing contact between members of the Society and Headquarters. In doing this, the President and Secretary of the Society visit various Local Sections and Student Chapter meetings, where they explain the organization and aims of the Society and, in turn, learn of the interests and work of members in different sections of the country.

For the current year, President Stuart and Secretary Seabury have so far made visits to: the Engineering Institute of Canada, at Montreal, on February 4–6; the Connecticut Section, at New Haven, Conn., on March 6; the North Carolina Section, at Charlotte, N. C., on April 20; the Central Ohio Section and the Student Chapter of Ohio State University, at Columbus, on April 28; the Mid South Section, at Memphis, Tenn., on April 30; and the Student Chapter of Washington University and the St. Louis Section, at St. Louis, on May 1.

On March 11, President Stuart attended the Annual Meeting of the American Railway Engineering Association in Chicago, Ill., while Secretary Seabury was present at the meeting of the Vermont Society of Engineers in Burlington, Vt., on March 12.

Revised Methods for Nominating Division Officers

Some difficulty has been experienced in the past by the Technical Divisions in securing the proper list of three nominees for the executive committees, from which the election of one member each year may be made. Some members have felt a hesitancy in appearing to compete with others for such election. Instead, it was urged that the nominating committee secure the approval of a single Corporate Member who will give his permission to have his name appear.

Upon inquiry it developed that there was a diverse feeling on the part of the Divisions as to the advisability of changing the present rules. Those who have had a fortunate experience under the present regulation felt disinclined to change. In order to accommodate both points of view, the Board of Direction has adopted a new ruling for this situation, stipulating that the nominating committee is to report "the names of one or more members of the Division," with the understanding that the total number so placed in nomination shall not exceed three for each office to be filled. Actual effect to this rule will be given at the next elections by the Technical Divisions.

Bridge Clearances

Clearances for bridges over navigable streams is a question of public importance which is now receiving much attention both officially and in general engineering circles. The official interest in the matter is reflected in the decision of the Corps of Engineers, U.S. Army, to hold a series of public hearings in its various offices throughout the country for discussion of these matters with reference to specific streams.

The more general engineering interest is reflected in the study just initiated by the new Engineering-Economics and Finance Division at the request of the Board of Direction. In the words of the Board's minutes, a committee is "to formulate, if possible, the economic principles which should control with respect to bridge clearances, both horizontal and vertical; a definition of 'navigable' streams; and the rational flood heights on which clearances should be based."

The membership of the committee is not completed, but Past-President J. F. Coleman has been designated chairman. He has already begun work by addressing inquiries to members, known to be widely experienced, asking for their observations and their contributing data.

News of Local Sections

ALABAMA STATE SECTION

At the meeting on April 10 of the Alabama State Section, 46 members and guests were present. "The Activities of the Alabama State Bridge Holding Corporation" was the topic of a paper presented by H. H. Houk, while J. G. Allen gave an illustrated talk on the "Lee's Ferry Bridge."

CENTRAL OHIO SECTION

An informal joint dinner meeting with the Ohio State University Student Chapter was held in Columbus by the Central Ohio Section, on April 28, in honor of President Stuart and Secretary Seabury. "The Romance and Adventure of Engineering" was presented by President Stuart, and a talk on the affairs and activities of the Society was given by Secretary Seabury.

CINCINNATI SECTION

On April 23, the Cincinnati Section held its annual meeting, at which 45 members and guests were present. The following officers were elected for the coming year: Hunter W. Hanly, President; H. H. Kranz, Vice-President; and Clifford N. Miller, Secretary-Treasurer. The speaker of the evening was Col. H. M. Waite, recently elected Vice-President of the Society, and Chief Engineer for the Cincinnati Terminal Company, who gave an illustrated talk on the Union Terminal Project.

COLORADO SECTION

Denver was the scene of the regular meeting of the Colorado Section, held on March 16. An enjoyable dinner was followed by an interesting talk by Dr. P. G. Worcester, of the University of Colorado, whose subject was "The Geology of Colorado." This was supplemented by views showing the different formations found in the state. There were 30 members and guests present.

A meeting of the Section was held in Denver, April 27, with 30 members and guests in attendance. The guest speaker was Rev. A. W. Forstall, of Regis College, who selected for his subject "When the Earth Trembles." This interesting talk on seismology was illustrated by motion pictures of the effect of earthquakes in many sections of the earth.

DAYTON SECTION

A meeting of the Dayton Section was held March 9, with 25 in attendance. Through the courtesy of the Stone and Webster Company, several reels of motion pictures, depicting the construction of the Conowingo Hydro-electric Development, were shown.

At the meeting on April 13, F. H. Eno, Research Professor of Highway Engineering at Ohio State University, gave an illustrated lecture on "Six Years of Soil Research in Ohio," which proved interesting and instructive. There were 30 members and guests in attendance.

DETROIT SECTION

An address by G. H. Fenkell was the feature of the Section's meeting held at Ann Arbor on March 28. The subject of Mr. Fenkell's talk was "The New Thirty Million Dollar Water Supply Project of Detroit," which he has helped to organize and develop. In giving a brief history of the development, he introduced, successively, his assistants in charge of various phases of the work. Each of these, in turn, spoke in an interesting manner on the work which he had covered.

DULUTH SECTION

Plans were discussed at the regular luncheon meeting on April 20, for the entertainment of the visitors at Duluth during the 1931 Fall Meeting of the Society. The manager of the Duluth Water and Light Department, Earl Kelly, was the speaker for the occasion and chose as his topic, "Safe Water Supply for the City of Duluth."

LEHIGH VALLEY SECTION

Frequent meetings of the Lehigh Valley Section were held in Bethlehem, Pa., during the past year. Among the speakers at these various meetings were: Dana Allston, Designing Engineer of the Port of New York Authority; Prof. George E. Beggs, of Princeton University; and Dr. Paul R. Heyl, of the U.S. Bureau of Standards.

At the meeting on March 9, Dr. Elwood Mead, U.S. Commissioner of Reclamation, Washington, D.C., gave an interesting lecture on the Hoover Dam. This meeting, which was held jointly with the Lehigh Valley Engineers' Club, was the season's largest.

At the annual meeting in December, the following officers were chosen for the year: Frederick E. Schall, President; Willis A. Slater, First Vice-President; Lynn Perry, Second Vice-President; and M. O. Fuller, Secretary-Treasurer.

LOS ANGELES SECTION

On May 13 the Los Angeles Section met in joint session with the Student Chapter of the California Institute of Technology at Pasadena. Dinner was served to the Section in the Hall of the Associates in the newly completed Athenaeum at the Institute. An illustrated talk was given by Dr. Robert T. Knapp, who spent 1929–1930 in Europe as the John R. Freeman Traveling Scholar in the study of modern hydraulic laboratory practice, on "The Function of a Modern Hydraulic Laboratory in the Development of Related Engineering Projects." Dr. Knapp is now professor in charge of Power Plant and Hydraulic Laboratories.

Prior to the dinner, the Junior Forum was led by Fred S. Condit, a Junior member, who spoke on "Petroleum Pumping Methods."

MID SOUTH SECTION

The Mid South Section held its second annual convention at Memphis on April 30 and May 1. Members of the Society were invited to attend. Officers for the Section were elected as follows: Harry N. Howe, President; H. A. Wiersema, R. E. Warden, L. R. Parmelee, L. W. Mashburn, G. R. Clemens, and Maj. L. D. Worsham, Vice-Presidents; and A. M. Lund, Secretary-Treasurer.

During the first day, addresses were given by President Stuart, Secretary Seabury, Maj. Brehon B. Somervell, U.S. Corps of Engineers, and Kenneth Markwell, Engineer, Harbor Commission. The Section met in a joint luncheon session with the Engineers' Club of Memphis at which Thomas H. Allen, Consulting Engineer of Memphis, spoke on "The New Sheahan Pumping Station." This was followed by a talk by Edward P. Klewer of the Planning Commission, on "The City of Memphis." Inspection trips to various points of interest in the Memphis vicinity were organized in the afternoon.

On Friday, the speakers were J. F. Coleman, Past-President of the Society, and T. T. Knappen, Area Engineer.

METROPOLITAN SECTION

The result of the canvass of ballots from the 1,230 members of the New York Section resulted in reorganizing amendments to both the constitution and by-laws of the Section. One of the amendments results in the change in name to the Metropolitan Section. Convening in the auditorium of the Engineering Societies Building, New York, the annual meeting of the Section was held on the evening of May 20, 1931. At this time, the following officers were elected: George L. Lucas, President; William F. Reeves, Vice-President for one year; Col. William J. Barden,

JOINT LUNCHEON OF THE MID SOUTH SECTION AND THE MEMPHIS ENGINEERS' CLUB
During Annual Meeting of Mid South Section, April 30, May 1, 1931

Vice-President for two years; William J. Shea, Secretary for one year; and Charles E. Trout, Treasurer for two years. As directors, Howard P. Barnes, Van Tuyl Boughton, and Theodore R. Kendall were elected for one year; and Dean G. Edwards, Sigvald Johannesson, and James F. Sanborn were elected for two years. The retiring president, Arthur S. Tuttle, paid tribute to the activity of the Section which during the past year has grown from 644 to 1,230. The average attendance at meetings has been 470.

Presenting the paper of the evening, General R. C. Marshall, Jr., Chief of the Construction Division of the Army during the war, pointed out the part the civil engineer must play in the stabilization of employment through long-range planning in public works.

In discussion, Major John F. Sullivan, Commissioner of City Planning of New York, showed that the value of Municipal work in New York is already practically equal to that of the Government.

Other discussions of the problem were presened by Francis Lee Stuart, President of the Society, and by L. W. Wallace, Executive Secretary, American Engineering Council.

Louisiana Section

The annual meeting of the Louisiana Section was held in New Orleans, April 8. Brief talks were given by J. F. Coleman, Past-President of the Society; Allen T. Dusenbury, Director of the Society; Col. Mark Brook and Capt. Phillip G. Bruton, of the U.S. Corps of Engineers; and Harry Jacobs, Chief Engineer, Louisiana State Board of Engineers. The following officers were elected for the coming year: Clarence N. Bott, President; George P. Rice, First Vice-President; John Riess, Second Vice-President; Richard L. Moroney, Treasurer; and John H. O'Neill, Secretary.

Milwaukee Section

A luncheon meeting of the Section was held on March 30, with both members and guests in attendance. The speaker of the occasion, Alonzo J. Hammond, addressed the gathering on the subject of "Railway Passenger Terminals," speaking particularly of the growth and importance of railroads in the United States which, he said, warranted the expenditure of considerable sums for imposing union terminal structures.

Northwestern Section

A joint meeting of the Northwestern Section and the Engineers' Society of St. Paul took place in that city on April 13. About 60 members of the two societies were present. The speaker was Congressman Melvin J. Maas, who addressed the meeting on "The Political Aspects of the St. Lawrence Waterway." Among other points, Mr. Maas stated that opposition to the waterway had materially lessened because of the realization on the part of Montreal and New York that their interests, as ports, would be greatly served by it.

Oklahoma Section

The spring meeting of the Oklahoma Section, held at the Oklahoma Agricultural and Mechanical College on April 23, was attended by 64 members and guests. During the dinner, L. M. Bush President of the Section, Dean Phillip S. Donnell, of the college, and Dean J. H. Felgar, of the University of Oklahoma, gave interesting talks. Later in the evening, an illustrated lecture was given by Prof. Wouter Bosch on the reclamation of the Zuyder Zee in Holland.

Philadelphia Section

The Philadelphia Section held its annual meeting devoted to Student Chapter interests and activities, on April 15. An interesting talk was given by Thomas W. Hulme, Vice-President of the Pennsylvania Railroad, in charge of real estate valuation and taxation, who spoke on business experiences as related to engineering education. Then Dean Robert H. Fernald, of the University of Pennsylvania, and Prof. Charles G. Thatchers, of Swarthmore College, spoke on fields of engineering employment and liberalizing the engineering curriculum.

Sacramento Section

Meetings of the Sacramento Section, held weekly during the year, have been exceptionally well attended. Among the speakers at the various meetings were Joseph W. Gross, Municipal and Reclamation Engineer of Sacramento; C. F. Adams, Assistant Superintendent of the Oleum Refinery, Union Oil Company; Ashley C. Brown, Entomologist with the State Division of Agriculture; W. J. Delehanty and J. M. Dodds, of the General Electric Company; H. R. Youngblood, Assistant Superintendent of the State Motor Vehicle Department; and Emory Smith, of the Smith-Emory Company of San Francisco.

On April 14, a meeting of the Section was held at which I. C. Steele, Chief of the Division of Civil Engineering of the Pacific Gas and Electric Company, addressed the meeting on "The Mokelumne River Development of the Pacific Gas and Electric Company." There were 68 members and guests present.

San Francisco Section

A special meeting of the Section was called on March 15, at which 155 members and guests were present. After the business meeting, C. E. Grunsky, Past-President of the Society, was requested to make a few remarks on the life of Marsden Manson, a former member of the San Francisco Section, who recently died. A talk, "Impressions Gained from a Trip Through Russia," given by Ralph Budd, was received enthusiastically.

At the meeting on February 17, H. A. Van Norman, Chief Engineer and General Manager of the Bureau of Water Works and Supply, City of Los Angeles, gave an illustrated address on "Los Angeles Water Supply Problems." There were 140 members and guests in attendance.

Seattle Section

The regular monthly meeting of the Seattle Section was held on April 17, in conjunction with a meeting of the Engineers' Club of Seattle. Following the dinner and business meeting, C. P. Ryan, of the Tacoma Section, outlined the program for the National Convention of the Society which is to be held in Tacoma this year. The speaker on this occasion, O. Laurgaard, City Engineer of Portland, Ore., addressed the Section on the "Development of Modern Cities." There were 36 members present.

Tacoma Section

An illustrated presentation of the engineering problems and accomplishments of the second unit of the city's great Cushman Power Project was given at the regular monthly meeting of the Section, held in April. Commissioner Ira S. Davisson introduced the engineering staff of his department and commended them on their work on this project. Members of this staff are Alvin F. Darland, Superintendent of electric design and construction; V. R. Rathbun, Design Engineer; and V. Gongwer, Superintendent of hydraulic design and construction, and Resident Engineer in charge during the entire construction period of the second unit.

To fill the vacancy caused by the death of J. L. Stannard, late President of the Section, R. K. Tiffany, a Consulting Engineer, with offices at Olympia, was chosen for the position. City Engineer, C. E. Putnam, was elected to fill the post of Vice-President, formerly held by Mr. Tiffany.

Student Chapter News

Carnegie Institute of Technology Student Chapter

A number of interesting programs have been given during the past year at the meetings of the Carnegie Institute of Technology Student Chapter. These were exceptionally well attended, the average attendance being about 50. According to the annual report of the secretary, 30 meetings were held during the year 1930, one for almost every week in the school year. Among the speakers were S. M. Seisel, President of the S. M. Seisel Company; Dr. L. A. Grondahl, Director of Research of the Union Switch and Signal Company; and George L. Hendrickson, of the Bureau of Water Supply of the City of Pittsburgh.

Of the 43 members of the Chapter, the following have been elected officers for this year: Lawrence M. Baugh, President; H. Evans, Jr., Vice-President; Sturges L. Stentz, Treasurer; and Charles E. Selsam, Secretary.

Custis Lee Engineering Society Student Chapter

In the annual report from the Custis Lee Engineering Society Student Chapter, the following officers for 1930–1931 were announced: D. B. Cook, President; E. F. Pilley, Vice-President; M. Suter, Treasurer; and H. O. Winston, Secretary. At the annual banquet, and at previous and subsequent meetings,

interesting talks on vital subjects were given. Motion pictures were used on two occasions as illustrative material. Among the speakers were Prof. William T. Tyle, and Prof. Hale Houston, both members of the staff of Washington and Lee University; and Dr. Robert W. Dickey. The Chapter membership totals 30.

IOWA STATE COLLEGE STUDENT CHAPTER

During the past winter the Student Chapter of the Iowa State College has had a number of interesting meetings, at one of which "The Empire State Building" was the subject under discussion. A great many members of the Chapter attended the recent meeting of the Iowa Engineering Society in Des Moines.

LEHIGH UNIVERSITY STUDENT CHAPTER

Meetings of the Lehigh University Student Chapter were held regularly each month during the past year. Interesting talks featured the programs, and among the speakers were: Wilson T. Ballard, of the Greiner Construction Company; Joel D. Justin, Hydro-electric Engineer; Col. William A. Starrett; Dr. Glennon Gilboy, an authority on soil mechanics; and Dr. Elwood Mead, Director of the U.S. Bureau of Reclamation.

The last meeting of the year was held on May 7. A lecture on the Empire State Building, illustrated by motion pictures, was given by Aubrey Weymouth, Vice-President and Chief Engineer of the Post and McCord Company. There were 350 in attendance.

The following officers were elected for the coming year: C. H. Robson, President; J. J. Antioniotti, Vice-President; R. I. Fluck, Secretary; and J. D. Strachan, Treasurer.

MISSOURI SCHOOL OF MINES AND METALLURGY STUDENT CHAPTER

Various interesting and timely lectures have been presented before the Missouri School of Mines and Metallurgy Student Chapter during the past year. At the final meeting of the school year, held at Rolla, April 29, there were 70 in attendance. Officers for the coming school year were elected as follows: E. W. Heilig, President; W. J. Ware, Secretary-Treasurer.

OKLAHOMA AGRICULTURAL AND MECHANICAL COLLEGE STUDENT CHAPTER

Considerable interest has been shown by members of the Student Chapter of the Oklahoma Agricultural and Mechanical College, who have thoroughly enjoyed talks by several well known engineers at their various meetings. Among the speakers were J. E. Kirkham, Bridge Engineer; and H. E. Parker, City Engineer of Tulsa, Okla. The Chapter assisted in the preparation of several exhibits which were part of the Annual Engineering Show, held during March.

PRINCETON ENGINEERING SOCIETY STUDENT CHAPTER

At a meeting on April 21 of the Student Chapter of the Princeton Engineering Society, the following officers were elected for the coming year: J. C. Savage, President; C. C. Davis, Vice-President; L. F. Moody, Secretary; and T. R. Frost, Treasurer. During the evening an interesting program was given, consisting of a talk by Gordon Armstrong, of the Youngstown Pressed Steel Company, and a moving picture of dam construction on the Saguenay River by the Aluminum Company of America.

According to the annual report, meetings during the year have been well attended. Some of the speakers were Lieut. W. P. Roop, U.S. Navy, and Dean A. M. Greene, Jr.

RENSSELAER POLYTECHNIC INSTITUTE STUDENT CHAPTER

A report from the Rensselaer Polytechnic Institute Student Chapter indicates that the regular monthly meetings of the Chapter during the past year have been enthusiastically attended. Among the speakers at the various meetings were W. J. Richardson; G. R. Solomon; F. W. Skinner; W. S. Lozier; and N. L. Nussbaumer. At the most recent meeting on April 15, H. O. Schermerhorn spoke on "Grade Crossing Elimination" with special reference to New York State.

The following have been chosen officers for the coming year: S. C. Richards, President; R. A. Norton, Vice-President; Van Wyck Lott, Jr., Secretary; and R. B. Watkins, Treasurer.

SYRACUSE UNIVERSITY STUDENT CHAPTER

On March 5, the Student Chapter of Syracuse University held a meeting at which a talk was given on the Carquinez Strait Bridge, illustrated by slides. At the meeting in February a similar talk was given on the Florianopolis Bridge.

The seniors of the Chapter were guests at a dinner given for them by Society members in Syracuse, which proved very entertaining. Talks were given by Edward P. Lupfer, and Marshall B. Palmer.

UNIVERSITY OF NEBRASKA STUDENT CHAPTER

Meetings of the University of Nebraska Student Chapter, at which descriptive talks were given on various engineering projects,

UNIVERSITY OF NEBRASKA STUDENT CHAPTER GROUP

were held at regular intervals throughout the school year. Among the speakers were M. I. Evinger, Professor of Civil Engineering at the University; and R. O. Green, Executive Secretary of the Nebraska Chapter of the Associated General Contractors.

UNIVERSITY OF NEVADA STUDENT CHAPTER

Monthly meetings have been held by the University of Nevada Student Chapter during the past year. At the last meeting of the current school year, held in Reno, April 9, officers for the year 1931–1932 were elected as follows: Gerry Brumund, President; Horace Church, Vice-President; and LeRoy Russell, Secretary-Treasurer. The feature of the occasion was an address by Gerry Brumund on a report of the "Water Resources of Southern California," upon which he had worked during a vacation.

UNIVERSITY OF MINNESOTA STUDENT CHAPTER

During the past year the University of Minnesota Student Chapter has held frequent meetings at which interesting talks by well known engineers were given. Among these were: Hibbert Hill, U.S. Army Engineers; W. N. Carey, City Engineer of St. Paul; C. L. Motl, Assistant Maintenance Engineer of the Minnesota Highway Department; E. S. MacGowan, Service Engineer for the Universal Portland Cement Company; Leif Sverdrup, Consulting Engineer; M. F. Clements, Bridge Engineer for the N.P. Ry. Co.; and L. G. Straub, Professor of Hydraulics.

At a meeting of the Chapter on May 5, a talk on "Twin City Sewage Disposal Plan" was given by J. A. Childs, Chief Engineer of the Metropolitan Drainage Commission.

UNIVERSITY OF PITTSBURGH STUDENT CHAPTER

Unusual and gratifying interest in the meetings of the Chapter during the past year is shown by the large attendances recorded in the annual report. The programs were arranged to cover a variety of subjects, on which talks were given by professors on the university staff as well as by members of the Student Chapter.

UNIVERSITY OF WISCONSIN STUDENT CHAPTER

Meetings held during the past year by the University of Wisconsin Student Chapter offered interesting programs and were exceptionally well attended. Among the speakers were Lieut. D. A. D. Ogden of the U.S. Army Engineers; Frederick E. Turneaure, Dean of the University's College of Mechanics and Engineering; and L. F. Van Hagan, Professor of Railway Engineering.

There was an attendance of 50 at the most recent meeting held on April 15. Through the courtesy of the Great Lakes Dredge and Dock Company moving pictures were shown on land reclamation and these proved of unusual interest.

WORCESTER POLYTECHNIC INSTITUTE STUDENT CHAPTER

Quarterly meetings have been held by the Worcester Polytechnic Institute Student Chapter during the past year. Each of the meetings featured interesting talks by the senior Student Chapter members. The third annual banquet of the Chapter, at which 72 members and guests were present, comprised the last regular meeting of this year. The speaker of the evening was Harold Robinson. The following officers were elected for the coming semester: Paul Nelson, President; Joseph Doyle, Vice-President; Rocco La Penta, Treasurer; and Gordon Whittum, Secretary.

ITEMS OF INTEREST

Engineering Events in Brief

To Be Found in the Next Issue

IN THE JULY issue of CIVIL ENGINEERING will be featured a group of interesting papers on subjects of wide diversity. Among these will be one by George K. Burgess, Director of the United States Bureau of Standards, on the National Hydraulic Laboratory, contract for which has recently been awarded.

From the West will come a discussion of the safety limitations of Hoover Dam, by Martin H. Gerry, Jr., M. Am. Soc. C.E., Consulting Engineer of San Francisco. In another paper, Leroy C. Smith, Assoc. M. Am. Soc. C.E., Engineer Manager of the Wayne County Board of Road Commissioners, in Detroit, will describe the most recent developments of the Detroit Metropolitan Highways.

So great has been the increase in traffic over the bridges of Metropolitan New York, that several unique methods of increasing their vehicular capacity have been developed. How these plans have been put into execution will be explained by E. A. Byrne, M. Am. Soc. C.E., Chief Engineer, Department of Plants and Structures, New York City.

Other equally valuable articles from a broad range of engineering activities will complete the forthcoming issue, which will be rounded out with numerous letters received from readers commenting on previous papers and on subjects of general interest to the profession.

Water Pipe Cast in 1817

A SECTION of the oldest cast-iron water pipe in the United States was excavated in Philadelphia recently. According to C. T. Hayes, Chief of the Bureau of Water Supply, it was laid over a century ago, and has served the city ever since without interruption. He states that examination showed it to be in excellent condition and still capable of functioning for an indefinite period.

This pipe is a part of the system installed in 1817. Prior to that time all water mains in Philadelphia and, in fact, in the whole country, were of wood. About 1800, Philadelphia's Water Committee decided to make a study of better water carrying facilities and as a result decided to import from England a small quantity of cast-iron pipe to be laid as an experiment. Results were so satisfactory that from time to time iron pipes were put in to take the place of wood. The pipe just excavated, actually 104 years old, is a piece of the early pipe imported from England.

It is of the bell and spigot type and is in 9-ft. lengths. A curious feature, which was mentioned in a paper by Marshall R. Pugh, M. Am. Soc. C.E., on page 810 of TRANSACTIONS for 1915, is that each length has three or four ribs or rings around it, approximately $1^1/_2$ in. wide. It was apparently intended that the pipe should be tapped at these places, which are thickened and therefore afford a better base for tap connections.

When, in 1817, the city fathers of Philadelphia laid down the first cast-iron pipe, they had just completed a 16-year study of all sorts of water conveying devices. The records of these studies are still available and make interesting reading. Up to that time cast iron had not been used in this country for such a purpose. In Europe, however, there had been some noteworthy installations, the earliest being that in the parks of Versailles, where, in 1664, by order of Louis XIV, cast-iron pipes were laid from the reservoirs of Picardie to those of Montbaron, together with a spring water conduit, to supply the town as well as the fountains. These cast-iron pipes, now 267 years old, are still in service.

Previous to the use of cast-iron for piping, and even during the early days of its adoption, pipes made of wood and some made of lead were used. In the City of London much wood pipe was installed, but old reports state that this had to be completely renewed every 20 years.

This information, for which the Society is indebted to city officials of Philadelphia, will appeal particularly to many members who are active in solving water supply problems.

Shrinkage and Cracks in Concrete of Dams

AN EXCEPTIONALLY valuable monograph entitled "Shrinkage and Cracks in Concrete of Dams," by Dr. Fredrik Vogt, Assoc. M. Am. Soc. C.E., of Norges Tekniske Hoiskole, Trondhjem, Norway, has been received from the author and will be available to members at the Engineering Society's Library, 29 West 39th Street, New York City.

Although Dr. Vogt does not pretend to have solved the innumerable shrinkage problems, he hopes to contribute to the information already gathered with such an end in view, and at the same time to encourage dam owners to inaugurate the systematic measurement of dams as the only possible means of solving such a problem.

Detailed and personal investigation of dams in the United States, Germany, Switzerland, Austria, Italy, Norway, and New Mexico, together with previously secured records of a similar nature, form the basis for this treatise. It has been amplified by able and masterly discussion.

The monograph is written in English but contains an extensive bibliography, which comprises books in many languages. In some measure it is a by-product of the work of the Committee on Arch Dam Investigation of the Engineering Foundation, in which activity the Society has cooperated.

COMING EVENTS

WESTWARD, HO!

SUMMER MEETING OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS

Convenes in Tacoma, Wash.

July 8, 9, 10, 1931

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS
Summer Convention in Ashville, N.C., June 22–26

AMERICAN MINING CONGRESS
St. Louis, June 5

AMERICAN SOCIETY OF MECHANICAL ENGINEERS
Regional Meeting, Hartford, Conn., June 1–3
National Applied Mechanics Meeting, Purdue University, Lafayette, Ind., June 15, 16
National Oil and Gas Power Meeting, University of Wisconsin, Madison, Wis., June 23–26

AMERICAN SOCIETY FOR TESTING MATERIALS
Thirty-Fourth Annual Meeting, at The Stevens, Chicago, June 22–26

AMERICAN STANDARDS ASSOCIATION
Meeting in New York City, June 11

NATIONAL CONFERENCE ON CITY PLANNING
Rochester, N.Y., June 22–24

NEW YORK STATE SEWAGE WORKS ASSOCIATION
Spring Meeting at Freeport, L.I., June 5, 6

NORTHWEST ELECTRIC LIGHT AND POWER ASSOCIATION
Annual Convention in Boise, Idaho, June 17–20

PENNSYLVANIA SEWAGE WORKS ASSOCIATION
Annual Conference at State College, Pa., June 23, 24

PENNSYLVANIA WATER WORKS OPERATORS ASSOCIATION
Annual Convention at State College, Pa., June 25, 26

Guggenheim Medal for Aeronautics

THE THIRD Daniel Guggenheim Gold Medal for notable achievement in aeronautics has just been awarded to Dr. Frederick William Lanchester, of Birmingham, England, for contributions to the fundamental theory of aerodynamics. Dr. Lanchester is one of the world's leading authorities on aerodynamics and has made many contributions to the art of aviation.

The first award of the Guggenheim Medal was made to Orville Wright, and the medal was presented to him in Washington, on April 8, 1930. The second award was to Dr. Ludwig Prandtl, on whom the medal was conferred in September 1930, at Breslau, Germany. The medal was founded in 1927 by the Daniel Guggenheim Fund for the Promotion of Aeronautics, of which Harry F. Guggenheim, now Ambassador from the United States to Cuba, was then president.

An Interpretation of Transportation

TRANSPORTATION in its many aspects was the keynote of the Norfolk Meeting of the Society. Grouped together in this issue, the papers presented at the meeting form a symposium on movements of passengers and commodities by rail, by highway, by water, and by air. Because of this general emphasis, it is fortunate that the original of the cover picture of the June issue was made available for reproduction.

It is from an etching by Otto Kuhler, and is reproduced by the kind permission of the Schwartz Galleries of New York. Mr. Kuhler is not only an artist of recognized ability but is a designing engineer as well. His favorite subjects are things mechanical and industrial. In this etching he has shown an interpretation of transportation which might be entitled "Giants on Call."

NEWS OF ENGINEERS

T. S. O'CONNELL, who for the past 18 years has been District Engineer of the Arizona State Highway Department, has been appointed State Engineer.

HENRY E. RIGGS, Professor of Civil Engineering at the University of Michigan, has opened a consulting office in Ann Arbor for handling railroad and public utility regulation problems.

LEE S. TRAINOR has been appointed Chief Engineer of the Construction Division of the National Lime Association of Washington, D.C.

PAUL L. HOLLAND, formerly Staff Engineer with Mees and Mees of Charlotte, N.C., has been appointed Chief Engineer of the Maryland Public Service Commission.

W. R. HUTCHINS has been promoted from Office Engineer to District Engineer of the Arizona State Highway Department.

A. F. DANIEL, formerly of Dallas, Tex., has removed to Lufkin, Tex., where he is now City Manager.

RICHARD KHUEN, JR., formerly General Manager of Erection of the American Bridge Company, has been advanced to the position of Chief Engineer. He will continue his office in Pittsburgh.

ARTHUR RICHARDS has accepted an appointment as Village Manager of Mamaroneck, N.Y. He has resigned from his former position as Assistant Engineer with the New Jersey State Water Policy Commission.

W. R. EBERHARDT, Contracting Engineer for the H. K. Ferguson Company, a firm of Cleveland engineers and builders, is now Manager of the New York District, with offices in New York.

E. P. BABCOCK, formerly a Consulting Engineer of Los Angeles, Calif., has become Principal Assistant Engineer for I. F. Stern, of Chicago, Ill.

WALTER L. DRAGER has been appointed Senior Assistant Engineer of the New Jersey State Water Policy Commission in Trenton, N.J.

MALCOLM C. CLEVELAND, formerly Assistant Chief Engineer of the Lehigh Valley Railroad, has been appointed Chief Engineer of the Public Service Commission of New York State.

WILLIAM GOULD is Bridge Designer with the New Jersey State Highway Department. Prior to that, he was Assistant Engineer with the New York State Bridge and Tunnel Commission and New Jersey Interstate Bridge and Tunnel Commission.

JOHN N. EDY, recently City Manager of Flint, Mich., has been appointed the first City Manager of the City of Dallas, Tex.

CLARENCE R. CARTER has accepted the position of Chief Civil Engineer for the Gulf Pipe Line Company in Houston, Tex.

ROBERT A. VOELKER, formerly Senior Draftsman of the Metropolitan Division of the State Highway Department in Newark, N.J., has recently become connected with the Department of Streets and Sewers in Wilmington, Del.

WILSON T. HAMMOND is now Supervisor of Track for the Long Island Railroad in Woodside, L.I. He was formerly connected with the Pennsylvania Railroad.

JASPER H. INGS, who has been with the University of Toronto Hydraulic Laboratory, is now affiliated with the Beauharnois Construction Company, at Beauharnois, Province of Quebec, Canada.

GEORGE C. ANDREWS has become connected with the Midland Asbestos Corporation having his headquarters in Wabash, Ind.

OMAR W. WHITE has transferred from the Staff Engineering Department of the Kimberly-Clark Corporation, of Neenah, Wis., to the Bridge Department of the Wisconsin State Highway Department in Madison, Wis.

W. T. COBURN has been appointed Regional Utilities Officer at the U.S. Veterans' Hospital in Lincoln, Nebr.

Changes in Membership Grades

Additions, Transfers, Reinstatements, Deaths, and Resignations

From April 9 to May 8, 1931

ADDITIONS TO MEMBERSHIP

AXTHELM, FRED AUGUST. (Jun., Oct. '30.) 3419 Humphrey St., St. Louis, Mo.

BANZHAF, EUGEN. (Assoc. M., Mar. '31.) Pacific Coast Mgr., Sheet Piling Corp., Ltd., 672 Chamber of Commerce Bldg., Los Angeles, Calif.

BONYUN, RICHARD EVANSON. (Assoc. M., Apr. '31.) Asst. Engr., North Jersey Water Supply Comm., 46 Burnside Pl., Haskell, N.J.

BRICKNER, HUGO JOHN, JR. (Jun., Oct. '30.) 537 South Kenosha St., Tulsa, Okla.

CASE, JOHN ARTHUR. (Assoc. M., Nov. '30.) Asst. Hydr. Engr., State Div. of Water Resources, 2680 Ninth Ave., Sacramento, Calif.

CHAPMAN, IRVING ELISHA. (Assoc. M., Feb. '31.) Engr., Associated Oil Co., Box 614, Sacramento, Calif.

CHERNIACK, NATHAN. (Assoc. M., Apr. '31.) Analyst, Port of New York Authority, 80 Eighth Ave., New York, N.Y.

CHINDBLOM, RICHARD NELSON. (Jun., Apr. '31.) Asst., Hydr. Div., Eng. Dept., Byllesby Eng. & Management Corp., Chicago, Ill.

CLARK, JOHN HARLEY, JR., (Assoc. M., Feb. '31.) Senior Insp., State Dept. of Highways, 711 Liberty St., Franklin, Pa.

CRONIN, WILLIAM WALTER. (M., Apr. '31.) Deputy City Engr., 1010 State Tower Bldg., Syracuse, N.Y.

DELANO, EDWARD RAWLINGS. (Jun., Nov. '30.) 245 South 2d St., Chillicothe, Ill.

DEVEREUX, GEORGE FRANCIS. (Assoc. M., Mar. '31.) Structural Checker, New England Power Constr. Co., Boston, Mass.

DORITY, ALEX OUSLEY. (Jun., Feb. '31.) Draftsman, Cincinnati Union Terminal Co., 1021 Temple Bar Bldg., Cincinnati, Ohio.

EAST, LOREN WILLIAM. (Jun., Jan. '31.) Asst. Engr., Gas and Elec. Div., California Railroad Comm., San Francisco, Calif.

FINDLEY, MARSHALL GREGORY. (Assoc. M., Mar. '31.) Structural Designer, Harbor Comm., Room 711, City Hall, Milwaukee, Wis.

FORSBERG, RUDOLF PERCY. (M., Mar. '31.) Prin. Asst. Engr., P. & L. E. R.R., P. & L. E. Terminal Bldg., Pittsburgh, Pa.

FREEMAN, ERNEST MAYNARD. (Assoc. M., Oct. '30.) Cons. Structural Engr., 414 Levy Bldg., Shreveport, La.

FREESTONE, GEORGE STANLEY. (Assoc. M., Feb. '31.) Care, Bank of Montreal, Victoria, B.C., Canada.

FUHRMAN, RALPH EDWARD. (Jun., Nov. '30.) Care, The State Board of Health, Jefferson City, Mo.

GEARHART, PETER CAMERON. (Jun., Nov. '30.) 245 Lincoln Ave., Bellevue, Pa.

HADSALL, JOHN MCINTYRE. (Jun., Apr. '31.) Archt's Representative, Voorhees, Gmelin & Walker, New York, N.Y.

HATFIELD, WILLIAM PAUL. (Assoc. M., Apr. '31.) Civ. Eng., Div. of Bridges and Bldgs., City of St. Louis, St. Louis, Mo.

HEYDT, FREDERICK GEORGE. (Jun., Apr. '31.) Engr. and Supt., M.F.C. Shoring & Foundation Co., Inc., 156th St. and Garrison Ave., New York, N.Y.

KISTLER, GLEN D. (Jun., Apr. '31.) Surveyman, U.S. Gov't., U.S. Engr. Office, Foot of Hayward St., Peoria, Ill.

KOEHM, EDWARD. (Jun., Nov. '30.) 140 Bayo Vista Ave., Oakland, Calif.

LESAIUS, HAROLD JOHN PAUL. (Jun., Oct. '30.) Care, Thompson-Starrett Co., Inc., 250 Park Ave., New York, N.Y.

MACMURRAY, DAVID CHARLES. (Jun., Dec. '30.) West Milford, N.J.

MAGLOTT, GEORGE FREDERICK. (M., Feb. '31.) 160 Broad St., Providence, R. I.

MALONEY, MARTIN FRANCIS. (Jun., Nov. '30.) 230 Ellsworth St., Gary, Ind.

MARTIN, ROBERT OLOF. (Jun., Mar. '31.) Junior Engr., Water Resources Branch, U.S. Geological Survey, Washington, D.C.

MARX, EMMET RAYMER. (Assoc. M., Nov. '30.) Cons. Civ. Engr., Consolidated National Bank Bldg., Tucson, Ariz.

MATTESON, FRANK AUGUSTUS, JR. 1806 South 4th Ave., Maywood, Ill.

MEISSNER, WILLIAM ALFRED. (Assoc. M., Apr. '31.) Transitman and Engr., L.V.R.R.; 431 Mercer Ave., Roselle, N.J.

MERZ, HENRY SPENCER. (Jun., Apr. '31.) Asst. Engr., Pearse, Greeley & Hansen, 130 North 1st St., Rockford, Ill.

MILLER, JOSEPH ALBERT. (Assoc. M., Mar. '31.) Structural Engr., Truscon Steel Co., 448 Canal Bank Bldg., New Orleans, La.

NABERS, JOHN BRADFORD. (Assoc. M., Nov. '31.) County Engr. and Res. Engr., Wilbarger and Hardemon Counties, Box 1412, Vernon, Tex.

ORBACZ, STANLEY EDWARD. (Jun., Nov. '30.) With State Highway Dept., 219 Cutler St., Schenectady, N.Y.

PEARSON, ARTHUR SEYMOUR. (Jun., Oct. '30.) Junior Engr., New York & Queens Light & Power Co., 250 Glen Ave., Yonkers, N.Y.

PETERSON, JOHN OSCAR. (Jun., Oct. '30.) With State Highway Dept., Box 486, Hamilton, Ill.

POLLOCK, ALFRED KENNETH. (Assoc. M., Feb. '31.) Asst. Res. Engr., Barnsley Corporation Water Works, Barnsley, Yorkshire, Eng.

PRICE, SIDNEY LESTER. (Jun., Nov. '30.) 1605 West 37th St., Kansas City, Mo.

REINOEHL, DONALD EARL. (Jun., Mar. '31.) Insp. and Draftsman, Clyde C. Kennedy, 543 Call Bldg., San Francisco, Calif.

ROBERTS, JAMES BENJAMIN. (Assoc. M., Oct. '30.) Box 1132, Austin, Tex.

ROBERTS, PAUL OSBORNE. (Jun., Feb. '31.) 104 South B St., Herington, Kans.

RUMSEY, JAMES RUTHERFORD. (M., Apr. '31.) Supt., Sewage Treatment Plant, City of Grand Rapids, City Hall, Grand Rapids, Mich.

SCHLEICHER, DAVID. (Jun., Oct. '30.) Asst. Engr., Westchester County San. Comm., 11 Cottage Pl., White Plains, N.Y.

SIECKE, KURT HUGO. (Assoc. M., Mar. '31.) Asst. Engr., Mo. Pac. R.R., St. Louis, Mo.

STANLEY, OWEN GARRETT. (M., Mar. '31.) Senior Engr., U.S. Engr. Office, 1000 California Fruit Bldg., Sacramento, Calif.

STEINERT, PETER FREDERICK. (Jun., Oct. '30.) Care, The Dorr Co., 247 Park Ave., New York, N.Y.

STEPHENSON, LAURENCE ERNEST. (Assoc. M. Apr. '31.) Asst. to Chf. Engr., Frederick Snare Corp., New York, N.Y.

TALLAMY, BERTRAM DALLEY. (Jun., Mar. '31.) Cons. Engr. (Sheehan, Fretts & Tallamy), 5488 Main St., Williamsville, N.Y.

TERRY, JACK MONTGOMERY. (Jun., Nov. '30.) 2616½ Speedway, Austin, Tex.

VANIA, FRANCIS HAROLD. (Jun., Oct. '30.) 885 Chestnut St., Springfield, Mass.

WARNER, EDGAR LESLIE. (Assoc. M., Mar. '31.) Mgr., E. W. Harrison Pipe Co., Tacoma, Wash.

WESTON, JAMES WILLIAM. (Assoc. M., Mar. '31.) Township Commr., Upper Moreland Township, 20 North Old York Rd., Willow Grove, Pa.

WINSTON, JOHN MCCLURE. (Assoc. M., Feb. '31.) 95 Thornton Ave., Fernbank, Cincinnati, Ohio.

WITHERBEE, MURVILL ARTHUR. (Jun., Nov. '30.) 2300 Delancy St., Philadelphia, Pa.

ZENTMYER, DONALD BOOKWALTER. (Assoc. M., Mar. '31.) Safety Engr., United Engrs. & Constructors, Inc., Philadelphia, Pa.

YOUNG, AUBREY DEBELL. (Jun., Dec. '30.) Asst. Engr. of Structural Design, Westchester County Park Comm., White Plains, N.Y.

MEMBERSHIP TRANSFERS

ALIN, AKE LUDVIG. (Assoc. M., '20; M., Mar. '31.) Hydr. Engr., U.S. Engrs., Portland Dist., 315 Customhouse, Portland, Ore.

ASHBROOK, CHESTER DANIEL. (Jun., '09; Assoc. M., '11; M., Jan. '31.) Gen. Contr. (C. D. Ashbrook & Cia., Ltda.), Casilla 514, Santiago de Chile, Chile.

BROWN, ELBERT CALVIN. (Assoc. M., '15; M., Mar. '31.) Senior Highway Engr., U.S. Bureau of Public Roads, 461 Market St., Room 807, San Francisco, Calif.

BURKART, EDWIN HOWARD, JR. (Jun., '27; Assoc. M., Mar. '31.) Senior Draftsman, P.R.R., Philadelphia, Pa.

CAMILLI, DAVID JOHN. (Jun., '26; Assoc. M., Jan. '31.) Asst. Engr., Allegheny County, Pittsburgh, Pa.

CARPENTER, SELLECK TOWNSEND MANN. (Assoc. M., '15; M., Apr. '31.) Vice-Pres., Crooker, Carpenter & Skaer, Inc., 406 Crosby Bldg., Buffalo, N.Y.

CRAIGMILE, CHARLES JAMES. (Assoc. M., '19; M., Mar. '31.) First Asst. to Asst. Chf. Engr., Wanaque Project, North Jersey Water Supply Comm., Wanaque, N. J.

EAGER, LESLIE HORTON. (Jun., Oct. '23; Assoc. M., Apr. '31.) Office Engr., U. S. Bureau of Reclamation, Box 277, Shoshone, Idaho.

GERAGHTY, LEO MATTHEW. (Assoc. M., '19; M., Apr. '31.) Engr., The Columbia Mills, Inc., Box 170, Minetto, N.Y.

GLEN, MICHAEL GABRIEL GOLLANDSKOV. (Jun., '27; Assoc. M., Apr. '31.) Engr., State Div. of Highways, San Bernardino, Calif.

GRAFFIN, EDWARD DAVID. (Assoc., M. '20; M., Apr. '31.) Lieut., C.E.C., U.S.N.; Power Supt. and Transportation Supt., Navy Yard, Quarters "S," U.S. Navy Yard, Mare Island, Calif.

GRASHEIM, WALTER EDMUND. (Jun., '21; Assoc. M., Apr. '31.) Engr., Clark Plastering Co. and Bldg. Products Corp., 47 Stanton St., Newark, N.J.

GUILD, WILBUR GILLFILLAN. (Jun., '27; Assoc. M., Jan. '31.) Designer, Standard Oil Co. of Indiana, Whiting, Ind.

HAWKINS, STANLEY MORRISON. (Jun., '27; Assoc. M., Feb., '31.) Asst. Engr., Frederick K. Wing Co., 1314 Prudential Bldg., Buffalo, N.Y.

MACKENZIE, DOUGLAS CARLYLE. (Jun., '24; Assoc. M., Dec. '30.) Asst. Engr., City Engr's Office, Pasadena, Calif.

MAREL, ARTHUR RICHARD CORBINIAN. (Jun., '28; Assoc. M., Feb. '31.) 5519 Blackstone Ave., Chicago, Ill.

MATLOCK, MICHAEL ALLAN. (Jun., '29; Assoc. M., Apr. '31.) Erection Engr., McClintic-Marshall Co., Pottstown, Pa.

PERSON, HJALMAR THORVAL. (Jun., '26; Assoc. M., Apr. '31.) Asst. Prof., Civ. Eng., Univ. of Wyoming, Laramie, Wyo.

POTTER, ALEXANDER. (Jun., '88; Assoc. M., '92; M., April '31.) Cons. Engr., 50 Church St., New York, N.Y.

REMLEY, JOHN FRANK. (Assoc. M., '26; M., Apr. '31.) Engr. in Chg., Baltimore Impvts., P.R.R., Room 301, Pennsylvania Station, Baltimore, Md.

ROGERS, LESTER CUSHING. (Jun., '16; Assoc. M., '24; M., Mar. '31.) Dist. Mgr., Bates & Rogers Constr. Co., 1612 Standard Bank Bldg., Cleveland, Ohio.

ROTHGERY, LEE JOSEPH. (Assoc. M., '26; M., Apr. '31.) In Chg. of Projects, Civ. Eng. Extension, Michigan State Coll., East Lansing, Mich.

SMITH, WILLIAM AUGUSTUS. (Assoc. M., '18; M., Mar. '31.) Village Engr., Tuckahoe and Bronxville, N.Y.; Town Engr., Eastchester, N.Y.; Civ. and Cons. Engr., 107 Lake Ave., Tuckahoe, N.Y.

WARNEY, VERNON EDWARD. (Jun., '27; Assoc. M., Apr. 13, '31.) Junior Structural Engr., Board of Education, 13 South Fitzhugh St., Rochester, N.Y.

WYCKOFF, WAYNE WELLINGTON. (Jun., '26; Assoc. M., Feb. '31.) Asst. Civ. Engr., Dept. of Water and Power, Los Angeles, Calif.

REINSTATEMENTS

HAGGARD, ASHLEY PEABODY, Assoc. M., reinstated Apr. '31.

RESIGNATIONS

AMES, ELMER RUEL, Assoc. M., resigned May, '31.

BAUR, EDWARD BERTRAND, Assoc. M., resigned Apr. '31.

BROWN, CLARK, Assoc. M., resigned Apr. '31.

FIERKE, MARVIN BAUER, Jun., resigned May, '31.

FOWLER, CHARLES EVAN, M., resigned May '31.

GAUGHER, LEON PHILIP, Jun., resigned Apr. '31.

GRAY, WALTER THOMAS, Assoc. M., resigned Apr. '31.

JOHNSON, GRANVILLE, M., resigned May, '31.

KEYS, EDWARD ALLEN, M., resigned Apr. '31.

MEAD, EMERSON MCCLEERY, Jun., resigned Oct. '29.

ROSENBERG, DAVID HOWARD, Jun., resigned Apr. '31.

STEINHAUER, GEORGE NATHAN, Jun., resigned Apr. '31

DEATHS

AULLS, HERBERT LEANDER. Elected M. July 1, 1885; died Apr. 25, 1931.

BURDEN, MORTON. Elected Jun., Feb. 4, 1896. Assoc. M., Jan. 2, 1901; died Apr. 15, 1931.

DAVIDSON, FRANK EUGENE. Elected M., Nov. 4, 1908; died Apr. 14, 1931.

EMORY, LLOYD TILGHMAN. Elected Jun., Oct. 5, 1909; Assoc. M., Apr. 2, 1912; M., Jan. 20, 1920; died Jan. 5, 1931.

FREW, ROBERT DICKSON ALISON. Elected Assoc. M., June 1, 1898; died Nov. 20, 1931.

HEREFORD, LEWIS STIRLING. Elected Assoc. M., Jan. 17, 1916; died Apr. 13, 1931.

WAGNER, FRED J. Elected Assoc. M., Apr. 4, 1906; M., Sept. 6, 1910; died May 24, 1930.

WARE, SAMUEL HOUSTON. Elected Assoc. M., May 12, 1919; died April 14. 1931.

WOODS, HENRY DICKINSON. Elected Assoc. M., Mar. 1, 1893; M., June 5, 1895; died Apr. 2, 1931.

TOTAL MEMBERSHIP AS OF MAY 8, 1931

Members	5,853
Associate Members	6,277
Corporate Members	12,130
Honorary Members	16
Juniors	2,666
Affiliates	133
Fellows	7
Total	14,952

Men and Positions Available

These items are from information furnished by the Engineering Societies Employment Service with offices in Chicago, New York, and San Francisco. The Service is available to all members of the contributing societies. A complete statement of the procedure, the location of offices, and the fees is to be found on page 97 of the 1931 Year Book of the Society. Unless otherwise noted, replies should be addressed to the key number, Engineering Societies Employment Service, 31 West 39th Street, New York, N.Y.

CIVIL ENGINEER, CONCRETE DESIGNER, CHECKER; Assoc. M. Am. Soc. C.E.; 43; married; civil engineering graduate; accountant; 12 years experience designing, detailing, checking reinforced concrete, commercial, industrial, public buildings, and structures, heavy foundations, rigid frames, bridges; 2 years experience as construction engineer and form detailer for concrete buildings. Location, Metropolitan District. C-2887.

BUILDING CONSTRUCTION ENGINEER; Assoc. M. Am. Soc. C.E.; available June 1 for California, Latin America, or Spain, but other locations would be considered; B.S. degree; registered structural engineer; 9 years estimating, designing, and managing construction fireproof buildings, including two years in Latin America. Speaks Spanish. C-7542.

CONSTRUCTION SUPERINTENDENT, ENGINEER; Assoc. M. Am. Soc. C.E.; 20 years varied experience in building construction, industrial buildings, warehouses, hotels, offices, tropical hospitals, structures, reinforced concrete, steel, wharves, piling foundations; contractors estimator, preparing plants, layouts, schedules, costs, field engineering, and design, in Latin American and United States. Speaks Spanish. B-9215.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; university graduate; married; registered in Michigan; 9 years experience in design and construction of concrete highways, city pavements, sewers, county drainage, and some building and industrial engineering; desires connection with contractor, municipality, or consultant; location, anywhere. C-7147.

STRUCTURAL ENGINEER, Assoc. M. Am. Soc. C.E.; 24 years practical experience; 10 years detailing and checking structural steelwork for leading fabricators; 14 years designing, structural steel, concrete, and timber structures. Available at once. Location, anywhere in United States. C-9270.

ENGINEER; Assoc. M. Am. Soc. C.E.; 36; registered engineer, Pennsylvania; licensed construction engineer and land surveyor, New Jersey; experienced in design and construction of industrial and commercial buildings, bridges, subway and elevated railways, municipal structures, airports, (site selection, grading, paving, drainage, lighting, and buildings); desires new connection, preferably eastern United States. C-9131.

CONCRETE ENGINEER; Assoc. M. Am. Soc. C.E.; 33; married; C.E. degree; desires position as reinforced concrete designing engineer or sales engineer; 3 years experience with prominent concrete contractor and 7 years with large reinforcing steel company. During past year was chief engineer for this company in Philadelphia. B-6853.

RECENT GRADUATE; experience in surveying and development work; desires field or office position; good draftsman and computor; chief of party and instrumentman on property subdivision, grade, and triangulation work; computor on city surveys, preparing instructions for field party. C-9288.

GRADUATE CIVIL ENGINEER; Jun. Am. Soc. C.E.; Lehigh University, 1930; desires position with construction concern in which work with productive results is expected with commensurate salary and chance for advancement. Available after fair notice to present employer. Eastern location preferred but not essential. C-9138.

YOUNG CIVIL ENGINEER GRADUATE; Jun. Am. Soc. C.E.; 23; single; 1 year experience railway location and construction; 1 year general bridge contracting; experienced in keeping cost records and estimating; desires work with construction or engineering firm; location immaterial; can furnish excellent references. C-9160.

CIVIL AND MECHANICAL ENGINEER; M. Am. Soc. C.E.; Cornell graduate; registered, Iowa; 20 years experience teaching engineering; has been in responsible charge various power and heating projects, appraisals, industrial reports, and irrigation and hydraulic enterprises; now employed managerial capacity. Desires connection where wide experience in engineering, financial, and educational matters is required. Excellent references. B-613.

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; registered professional engineer; college graduate; 10 years comprehensive experience in design and construction of industrial plants, river improvements, and municipal projects; has taught college courses in engineering. Desires teaching or similar position affording some opportunity for personal study. At present employed; available upon reasonable notice. C-7235.

CONSTRUCTION AND STRUCTURAL ENGINEER; M. Am. Soc. C.E.; licensed civil engineer, New Jersey; 20 years expesience projects, designs, estimates, supervision, construction, consultation, and promotion, including 10 years in China, Malaysia, Burma, India, and Ceylon. Desires position in foreign trade and engineering promotion, United States or abroad. C-2148.

CONSTRUCTION AND DESIGNING ENGINEER; Assoc. M. Am. Soc. C.E.; graduate, Lehigh University; experience in design and construction of office buildings, apartments, hotels, industrial and commercial buildings, including reinforced concrete construction and structural steel; 8 years in office of prominent consulting engineer in East. Available at once. C-9127.

CIVIL ENGINEER; 26; single; graduate, 1931; 1½ years experience in estimating and general engineering; 1 year foreign work—experience in triangulation and topographic mapping. Location immaterial. Available May 15. C-9162.

STRUCTURAL AND HYDRAULIC ENGINEER; Assoc. M. Am. Soc. C.E.; 38; married; graduate, University of Illinois; 14 years experience in field and office; design of hydraulic structures, bridges, buildings, and highways; construction of bridges and highways; hydraulic design and investigations; project estimates. Prefers Southwest or Middle West. C-9167-3049. Chicago.

PRESIDENT OF STATE ENGINEERING SOCIETY; M. Am. Soc. C.E.; reserve captain; 20 years experience in municipal, highway, drainage, surveying, and construction work; unemployed, with no salaried opportunity for past six months; wishes to know of some suitable position with reasonable pay; municipal work preferred. B-9712.

ENGINEERING EXECUTIVE; M. Am. Soc. C.E.; 25 years engineering, executive, and construction experience in municipal, highway, and allied lines. Responsible position desired. Middle States preferred. Available on short notice. C-8700.

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; graduate, Massachusetts Institute of Technology; married; 29; has successfully held positions as chief draftsman, designer, and resident engineer on large jobs, buildings, and bridges. Qualified as superintendent. Will consider foreman's or other subordinate job to make good connection. Available at once. Best references. B-9796.

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; 37; 15 years experience in designing, estimating, and pricing all items of general contracts, purchasing all materials, and expediting and supervising construction of all types of buildings; available at reasonable salary as project manager, estimator, expediter, or construction superintendent. B-4964.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 23; graduate, V.M.I.; licensed to practice as professional engineer in Virginia; 2 years experience in railway maintenance. Desires permanent position with engineering firm or consulting engineer. C-9181.

CONSTRUCTION EXECUTIVE; M. Am. Soc. C.E.; 47; experienced, draglines, steam shovels, suction dredges, and other excavating equipment; drainage and irrigation; tunnel and canal lining, quarry work, and river channel control; cost keeping and accounting. Expert in problems of organization. Available immediately. B-4138.

GRADUATE CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; 43; married; registered engineer, Michigan; 18 years railroad location, construction, and maintenance; 1 year assistant city engineer; 14 months oil refinery construction; 10 months oil corporation various departments; 5 months detailing and checking with bridge company; 10 years as assistant engineer on railroad construction, maintenance, and valuation. C-9011.

STRUCTURAL ENGINEER; Assoc. M. Am. Soc. C.E.; 42; married; Pennsylvania state license; 20 years broad experience, industrial and commercial projects; well qualified to handle designs, estimates, specifications, reports, and sales. Responsible position at reasonable salary desired. B-2924.

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; graduate; 35; New York and New Jersey licenses; experienced in design and construction of industrial plants, waterfront improvements, and public utility structures, writing specifications, preparing estimates, and letting sub-contracts. Desires connection with general contractor or consulting engineer. Metropolitan New York preferred. A-533.

GRADUATE CIVIL ENGINEER AND ESTIMATOR; Jun. Am. Soc. C.E.; 28; married; 1 year bridge design and construction; 4 years assistant to general building contractor; experienced in quantity take-off, pricing, sub-bids, and assembly on all types of general building; also in purchasing, expediting, drafting, and office management. Desires connection with reliable general contractor. C-5869.

GRADUATE CIVIL ENGINEER; Jun. Am. Soc. C.E.; 27; married; 6 years experience in building construction as field engineer and assistant superintendent on some of largest building operations in New York City; superintendent construction office building; varied experience from foundations to finish, theaters, clubs, and hotels. Desires position of similar nature in New York City or vicinity. C-3263.

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; university graduate; 18 years experience in flood protection, drainage, railway track work, and highway and hydro-electric construction. Available immediately. Location preferred, South. C-1035.

CIVIL ENGINEER AND CONSTRUCTION SUPERINTENDENT; Assoc. M. Am. Soc. C.E.; 30; university graduate; 13 years experience as construction engineer and superintendent on water, sewer, pavement, and bridge work. Good knowledge of estimating. C-9193.

GRADUATE CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; 41; 3 years railroad maintenance and construction valuation; 2 years army engineer, roads, docks, power transmission; 8 years public utilities, operating surveys, industrial audits, reports, power, railways, oil, gas companies; has directed employment personnel; 2 years department store, operation, warehousing, traffic, and delivery; 1 year personnel, training sales operating chain grocery stores. C-2015.

GRADUATE CIVIL ENGINEER; Jun. Am. Soc. C.E.; 28; 5 years experience detailing, checking, and designing all types of structures. Desires connection with architect or contracting or engineering firm. Available immediately. Location immaterial. C-2918.

LOCK-BAR STEEL PIPE IS AGAIN SELECTED—
for another important steel pipe installation

On May 13th, the Hackensack Water Company awarded to T. A. Gillespie Company the general contract for the installation of approximately eight miles of 52″ diameter Lock-Bar Steel Pipe. The line will run from the New Milford pumping station through New Milford, Bergenfield and Teaneck to Sheffield and Grand Avenues in Englewood, New Jersey.

The time-tested dependability of Lock-Bar Steel Pipe is recognized by prominent water works engineers throughout the country.

EAST JERSEY PIPE COMPANY
7 Dey Street, New York

LOCK-BAR
Before Closing
STRONG AS THE PLATE ITSELF

TUNNEL ENGINEER OR SUPERINTENDENT; M. Am. Soc. C.E.; 44; 20 years experience driving long railway, drainage, and power tunnels in rock; fully up on latest mechanical methods, including concrete lining with pneumatic pressure, plant selection, and layout. Location immaterial. Available after May 15. C-9209.

STRUCTURAL ENGINEER; Assoc. M. Am. Soc. C.E.; 31, married; desires responsible position; 10 years broad experience, structural design on railroad viaduct and station, elevated streets, industrial buildings, bins, conveyor galleries, bridges, cement and coke oven plants, also foundations. C-8644.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 21; graduate, Brooklyn Polytechnic Institute, highest honors; will receive Master of Science from Harvard; wants position with opportunity for advancement, in New York City; particularly interested in foundations; references. Available July. C-6206.

CIVIL AND INDUSTRIAL ENGINEER; Assoc. M. Am. Soc. C.E.; 25 years government, municipal, public service, and industrial projects; last 12 years partly devoted to industrial management problems, effecting economies and reorganization; record covers investigations, reports, designs, estimates, contracts, and supervision; university education. Invites contact with engineers or managers planning to develop broader fields. C-5717.

STRUCTURAL ENGINEER; Jun. Am. Soc. C.E.; 24; single; C.E. degree, Rensselaer Polytechnic Institute, 1928; to receive degree, D.Eng. in structural engineering, June 1931; 2½ months structural detailing; 3 months calculation properties structural shapes. Desires position structural design, research, construction, or instructorship. Available July 1. C-9229.

GRADUATE ENGINEER; Jun. Am. Soc. C.E.; 26; 5 years experience; competent as instrumentman, inspector, resident engineer, draftsman, and computor on highway work; experienced in design of roadway plans. Wishes employment at once anywhere in United States; can furnish references and letters of recommendation. C-4601.

TRANSMISSION ENGINEER; M. Am. Soc. C.E.; 47; married; 25 years experience electric power transmission lines, general layout, design all types of steel structures, specifications, sales negotiations, and drafting room supervision. Desires engagement, either engineering or sales, where experience and acquaintance in the industry will be an asset. C-9226.

SURVEYING AND GEOLOGY INSTRUCTOR; Jun. Am. Soc. C.E.; B.E. 1925; 3 years civil engineering field work; 2 years mining experience; 1 year graduate study in geology. Qualified to teach engineering geology and surveying. Interview anywhere in summer. C-2183.

COST REDUCTION EXECUTIVE; Assoc. M. Am. Soc. C.E.; Mem. A.S.A.E.; college graduate; nearly 20 years general industrial, utility, municipal, mining engineering, construction; prefers small progressive organization; moderate salary; can re-invest part of salary; consider consulting, part-time, non-competing units. Widely experienced, East, North, South. Employed at present. C-7486.

GRADUATE CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; 8 years varied, intensive experience in structural drafting, design steel, concrete, in connection with subway construction, building design, railroad work; familiar with field engineering construction; thorough, keen, alert, unlimited capacity to assume responsibility. Prefers field engineering construction work or connection with consulting engineer, contractor, construction company, where ability is appreciated. C-2605.

GRADUATE ENGINEER; Assoc. M. Am. Soc. C.E.; licensed engineer, New York; 32; single; 3 years experience on concrete building construction, including sliding forms; 1 year theatre and office building; 1 year subway underpinning; 3 years on heavy foundations; 2 years estimating foundation work. New York City or East. C-9231.

BUILDING CONSTRUCTION EXECUTIVE; Assoc. M. Am. Soc. C.E.; 15 years field and office experience; past 3 years general manager of construction large New York contractor; will invest $20,000 and services in established construction concern where capital is need for expansion. In prime of life and thoroughly equipped. C-1496.

PROFESSOR IN CIVIL ENGINEERING; M. Am. Soc. C.E.; open for position teaching highways, structures, or mechanics; American-born; graduate two universities with Ph.B., B.S., M.S. and C.E.; 20 years technical and administrative engineering experience; 5 years teaching; experienced writer and speaker with good personal qualifications. B-5954.

EXECUTIVE; M. Am. Soc. C.E.; M. Fla. Eng. Soc.; licensed structural engineer; experienced, plant operation, designing, estimating, erection steel bridges, buildings, office management, accounting, financing, sales, contracting, contact promotion; extensive acquaintance among prominent engineers, architects, and contractors, located in Southeastern States. Now operating engineer, contractor; initiative, activity. Available short notice. C-9265.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 24; single; graduate of Rensselaer Polytechnic, Institute, 1929; 4 summers of work with New York contractors; finishing 2-year course at Harvard Graduate Business School, June 1; familiar with cost work as well as technical engineering. Desires position with contracting firm or consulting engineer. C-9273.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 24; single; university graduate, 1928; 6 months general city surveying and drafting; 2 years location and construction of trunk-line sanitary sewers; triangulation and topographic surveys. Available at once. Desires work in Tropics. C-4280.

STRUCTURAL ENGINEER, ESTIMATOR, CONSTRUCTION MANAGER; Assoc. M. Am. Soc. C.E.; 36; married; licensed professional engineer; good mixer; 6 years field experience; 10 years with two prominent contractors in design, estimating flat slab, beam, and girder; tin pan systems, steel and slow burning; estimating, industrial, commercial, residential; familiar various floor systems and their economies. C-8566.

RECENT GRADUATE; Jun. Am. Soc. C.E.; 25; single; B. Sc. Rutgers University, 1929; M. Sc. University of Illinois, 1931; 2 years experience scientific research; knowledge of French and German. Desires position giving designing experience. Available at once. Location in the East preferred, but will go anywhere. C-9263.

CIVIL AND SANITARY ENGINEER; Assoc. M. Am. Soc. C.E.; 32; married; graduate, Massachusetts Institute of Technology; New York and New Jersey licenses; 10 years successful experience complete charge all phases of outstanding public works projects from inception to completion. Location subordinate to opportunity. Highest references. C-84.

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; 27 years experience drafting, land and topographic surveying, railroad, water supply, sewerage, drainage, and flood control engineering. Prefers vicinity of Washington, D.C. A-5125.

RECENT BOOKS

New books of interest to Civil Engineers, recently donated by the publishers to the Engineering Societies Library, will be found listed here. A comprehensive statement regarding the service which the Library makes available to members is to be found on pages 87 and 89 of the Year Book for 1931. The statements made regarding the books are taken from the books themselves and this Society is not responsible for them.

THE BUILDING ESTIMATOR'S REFERENCE BOOK. By F. R. Walker. 7 ed. Chicago, Frank R. Walker Company, 1931. 1,527 pp., illus., tables, 6½ × 4½ in., leather. $10.00.

A completely revised edition which contains complete, authentic, and up-to-the-minute estimating and cost data available, which have been condensed, as far as is practicable, for ready reference.

BRIDGE ENGINEERING. By F. O. Dufour and C. P. Schantz. Chicago, American Technical Society, 1931. 374 pp., illus., diagrs., charts, tables, 9 × 6 in., cloth. $3.00.

An elementary text for colleges and home study. The subject is presented simply and practically, and the application of the theory to ordinary railroad and highway bridges is shown in detail.

THE DOCK AND HARBOR AUTHORITIES' 1931 DIRECTORY. London, The Dock and Harbor Authority, 1931. 311 pp., 7 × 5 in., cloth. 5/6.

A convenient handbook which supplies correct information concerning the personnel and precise designation of members and officials of Harbor Authorities in different countries, as well as the tide range, depth of water, and population.

FLOW AND MEASUREMENT OF AIR AND GASES. By A. B. Eason. London, Charles Griffin & Co., Ltd., 1930. 254 pp., diagrs., charts, tables, 9 × 6 in., cloth. 20s. (Gift of J. B. Lippincott Company.)

This book treats of the friction of gases and the coefficient of friction in pipes, the question of suitable meters for gas and air, and the working of pneumatic tubes. The existing information is very fully summarized and presented in tables and graphs, with complete references to sources.

HYDRAULICS FOR ENGINEERS. By R. W. Angus. New York, Isaac Pitman & Sons, 1930. 300 pp., illus., diagrs., tables, 8½ × 5¾ in., cloth. $3.50.

After thirty years of experiment and practice in the field of hydraulic engineering and a parallel experience in the lecture room, the author has incorporated in this book the methods that he has found successful. Of unusual interest is the fact that an attempt has been made to deal with the subject without the introduction of difficult mathematics.

MAP DRAFTING AND LETTERING. By H. R. Saunders and H. C. Ives. Los Angeles, Benson Book Co., Inc., 1931. 345 pp., drawings, diagrs., tables, 9½ × 6½ in., cloth.

An interesting treatise on map drafting and lettering which thoroughly covers the finer details of map work and its closely associated subjects. It has been the aim of the authors to so divide this work that the inexperienced draftsman might follow the subjects in a natural sequence, whereas the experienced draftsman, in using it as a reference work, need consult only those sections with which he is unfamiliar.

POPULATION BY CENSUS TRACTS CLEVELAND AND VICINITY WITH STREET INDEX. By Howard W. Green. Cleveland Health Council, 1931. 41 pp., tables, drawings, 11 × 8½ in., 3 maps, cloth. $10.00.

This book is designed to present basic population data and to carry a street index which makes possible the geographical distribution of all sorts of statistical units. The data given are important for all who need population statistics for outlining industrial and commercial developments, for carrying forward projects for the improvement of social and living conditions, and for dealing with almost every phase of city planning.

RIGID-FRAME BRIDGE. By A. G. Hayden, G. D. Clarke, and G. E. Beggs. New York, John Wiley & Sons, 1931. 236 pp., illus., diagrs., tables, charts, 9 × 6 in., cloth. $4.50.

A treatise on the application of this construction to short-span, reinforced-concrete, and steel-frame bridges. The theory of design is developed in a simple form, without the use of higher mathematics, and practical information upon construction is included. The book is based upon experience gained in constructing the Westchester County, New York, parkways, where many bridges of this type have been built.

THE VEST POCKET ESTIMATOR. By F. R. Walker. 7 ed. Chicago, Frank R. Walker Company, 1931. 220 pp., 5½ × 2¾ in., leather.

Published in conjunction with *The Building Estimator's Reference Book*, this volume contains, in tabular form, material quantities and labor hours for estimating the cost of all classes of building construction.

T. J. SKILLMAN, Chief Engineer, Pennsylvania Railroad Company. A. R. WILSON, Engineer of Bridges and Buildings.

CURRENT PERIODICAL LITERATURE

Abstracts of Articles on Civil Engineering Subjects from Magazines in This Country and in Foreign Lands

Selected items from the current Civil Engineering Group of the Engineering Index Service, 29 West 39th Street, New York, N.Y. Every article indexed is on file in The Engineering Societies Library, one of the leading technical libraries of the world. Some 2,000 technical publications are received by the Library and are read, abstracted, and indexed by trained engineers. With the information given in the items which follow, you may obtain the article from your own files, from your local library, or direct from the publisher. Photoprints will be supplied by this Library at the cost of reproduction, 25 cents per page, or technical translations of the complete text may be obtained when necessary at cost.

BRIDGES

BASCULE, CHICAGO. New Bridge and Viaduct Track and Special Work Open Up Another Chicago Artery. *Elec. Traction*, vol. 27, no. 3, Mar. 1931, pp. 113–115, 8 figs. Wabash Avenue bridge and viaduct on north approach to Chicago River, providing separation of grades over streets and steam road tracks, afford new route for Chicago surface lines. Track construction; lightweight pre-cast slab paving on bridge; overhead construction.

CONCRETE ARCH, DESIGN. Recent Developments in Arch Design, W. L. Scott. *Concrete and Constr. Eng.*, vol. 26, no. 3, Mar. 1931, pp. 181–186, 2 figs. General review of theories underlying arch bridge design; recent innovations in bridge design practice.

CONSTRUCTION, WELDING. Reconditioning Short-Span Steel Bridges by Welding, C. B. Danneberg. *Roads and Streets*, vol. 71, no. 3, Mar. 1931, pp. 97–99, 10 figs. Report for County Highway Officials' Division of American Road Builders' Association; excessive deformation of chord angles checked by welding; continuity of stringers effected by welding; fillet welds supplemented by rivet welds; web-to-chord connection of small truss strengthened by welding; reinforcing low truss spans; increasing resistance of stringers; welding top-chord knee brace; strengthening floor beams; restoring efficiency of rusted members; welding applied to floor system.

HIGHWAY. Bridge Problems on Modern Highways, M. Goodkind. *Am. Highways*, vol. 10, no. 2, Apr. 1931, pp. 12–16. General studies which should be given to structure in order to accomplish desired results in most satisfactory manner; bridge location; preliminary foundation investigation; treatment of foundations; details of design and construction; economics of highway grade separations; and esthetic treatment.

LIFT. Tower-Mounted Hoists Lift Bridge Span, H. W. Fittenger. *Eng. News-Rec.*, vol. 106, no. 13, Mar. 26, 1931, p. 531, 1 fig. Description of railroad bridge across Tombigbee River in Alabama; movable span is entirely free of operating machinery. Lifting is by electric motors connected to driving drums in each tower with unusual electric control scheme for keeping span horizontal while in motion. Duplicate motors at each end are operated from same master controller, which should cause them to operate at nearly same speed.

MONTREAL. The Montreal Harbor Bridge. *Engineering*, vol. 131, no. 3400, Mar. 13, 1931, pp. 351–354, 10 figs., partly on p. 362. Highway bridge of exceptional length, height, and span recently completed across St. Lawrence, at Montreal; total length, including approach embankments, is 2 mi., of which 8,817 ft. are represented by steelwork. In main span, trusses rise between tracks and sidewalks. Remainder of bridge is of deck type with all supporting steelwork below traffic surfaces.

PLATE GIRDER, CONSTRUCTION. Placing Large Girders for Railroad Bridge. *Constructor*, vol. 13, no. 3, Mar. 1931, pp. 45–47, 10 figs. Report on placing of ten 120-ft. girder spans for carrying tracks of Missouri Pacific Railroad over Meramec River, in St. Louis County, Mo.

STEEL ARCH, MASSACHUSETTS. The Tyngsborough Project, A. E. Kleinert. *Boston Soc. Civil Engrs.—Jl.*, vol. 18, no. 3, Mar. 1931, pp. 82–91, 7 figs. Description of project at Tyngsborough, Mass. to replace obsolete bridge over Merrimac River and tracks of Boston & Maine Railroad, which will eliminate dangerous curve on interstate highway; design adopted provides for steel through-braced arch totaling 546 ft. 10 in. between centers of end of pins, rise of 96 ft., and depth of truss of 20 ft.; elimination of curve on highway requires placing of 40-ft. fill over reinforced concrete arch culvert which is to be 18 ft. wide, 11 ft. high, and 220 ft. long.

STEEL TRESTLE. Collapsible Construction Trestle Across Navigable Channel, L. C. Torell. *Eng. News-Rec.*, vol. 106, no. 13, Mar. 26, 1931, p. 533, 1 fig. Description of trestle, which folds down and lies on bottom when boats need to pass, being successfully operated in building navigation lock and dam on Mississippi River at Hastings, Minn.; posts of bent are hinged at bottom, and each span of stringers is hinged at top.

STEEL TRUSS. K-Type Bracing for Long-Span Bridge Trusses. *Eng. News-Rec.*, vol. 106, no. 14, Apr. 2, 1931, pp. 553–554, 4 figs. Description of supplementary rapid transit system of two bridges on new 38-mi. Connellsville extension of Pittsburgh & West Virginia Railway Co., utilizing K-type bracing for their web systems; crossings involve three double-deck K-braced trusses of 200, 350, and 450-ft. spans and single-track, deck-truss bridge over Youghiogheny River, with K-braced span of 370 ft.; economies claimed over Warren or Baltimore bracing for trusses up to 450-ft. span.

SUSPENSION, HUDSON RIVER. Two 3,500-Ft. Span Suspension Foot Bridges Rigid Without Stiffening Trusses, F. W. Skinner. *Eng. and Contracting*, vol. 70, no. 3, Mar. 1931, pp. 55–57, 6 figs. Report on construction of two catwalk suspension foot bridges, with sag of 325 ft. between tower tops, 3,500 ft. apart, of Hudson River Bridge, New York; two floor platforms, one mile long, were supported by thirty-six $2\frac{15}{16}$-in. twisted steel ropes and stabilized by novel funicular storm systems, completely eliminating serious distortions and wind vibrations; foot-walks cost about $600,000.

WOODEN, SPECIFICATIONS. Report on Wooden Bridges and Trestles. *Ry. Age (Daily Edition)*, vol. 90, no. 10B, Mar. 11, 1931, pp. 528-D48-50, 1 fig. Committee offered many suggestions for simplifying stocks and presented plans for overhead highway bridges. Before Am. Eng. Soc.

BUILDINGS

RADIO CENTER, NEW YORK CITY. Ground to be broken in June for $250,000,000 Radio Center in Heart of New York City. *Telegraph and Telephone Age*, no. 7, Apr. 1, 1931, pp. 147–148, 2 figs. Construction of Rockefeller-R.C.A. Radio City, will begin in June; steel skeleton has been ordered, and contract for erection of 125,000 tons of steel is let; steel will fill between 500 and 600 carloads; enough steel will go into it to build standard gage railroad between New York and Chicago, deliveries of steel will begin in November; birdseye view and street plan of buildings are given.

CITY AND REGIONAL PLANNING

HOUSING, NEW YORK. Buildings: Their Uses and the Spaces About Them. *Regional Survey of New York and Its Environs*, vol. 6, 1931, 465 pp., 168 figs. Volume contains following monographs and appendixes: The Character, Bulk, and Surroundings of Buildings, T. Adams; Housing Conditions in New York Region, T. Adams; Control of Building Heights, Densities, and Uses by Zoning, E. M. Bassett; Migration of Industry in New York Region for Years 1926–1927; Economic Production of Workingmen's Homes, G. Atterbury; Standardized Construction of Dwellings, W. H. Ham; Zoning Cases in United States, E. M. Bassett and F. B. Williams.

INDIA. India's New Capital City, A. Rouse and A. G. Shoosmith. *Surveyor*, vol. 79, no. 2042, Mar. 13, 1931, pp. 327–328, 1 fig. Design and construction of New Delhi; choice of site; problems of town planning; temporary housing problems; building materials; municipal services; comparisons of rates and costs.

ROCHESTER. City Planning in Rochester, E. A. Fisher. *City Planning*, vol. 7, no. 2, Apr. 1931, pp. 85–99, 4 figs. Former Superintendent of City Planning discusses recent progress and projects.

SAN JOSÉ, CALIF. San José Corrects Its Inheritance of Badly Laid Out Streets, M. H. Antonacci. *West City*, vol. 7, no. 4, Apr. 1931, pp. 23 and 47, 1 fig. Old California city will re-align five streets and construct new connecting bridge.

CONCRETE

AGGREGATES. The Use of Separated Sizes of Coarse Aggregate in the Proportioning of Concrete for Highway Construction, R. W. Crum. *Nat. Sand and Gravel Bul.*, vol. 12, no. 2, Feb. 1931, pp. 48–52 and (discussion) 53–56, 4 figs. Before Nat. Sand and Gravel Assn., previously indexed from Pit and Quarry, Feb. 11, 1931.

DESIGN, CHARTS. Short-Cuts in Structural Design—II, J. R. Griffith. *Concrete*, vol. 38, no. 4, Apr. 1931, pp. 36–38, 2 figs. Construction of chart for computing soil pressures under foundation walls of buildings, chimney footings, bridge piers, and similar cases.

MIXING. Concrete Mixture Design Controlled by Chicago & North Western, O. F. Dalstrom. *Concrete*, vol. 38, no. 4, Apr. 1931, pp. 21–24, 3 figs. Quantity of mixing water; yield of mixture and proportions for trial batches; testing aggregates for cleanness; classes of concrete; sampling aggregates; grading procedure; field mix by volume; net quantity of mixing water; yield of mixture; checking with trial batch; procedure for slump test; amount of slump desired; moisture content determinations. (Concluded.)

Some Notes on Proportioning Concrete, H. J. Vogan. *Instn. Engrs. Australia—Jl.*, vol. 3, no. 2, Feb. 1931, pp. 66–67. Discussion by C. F. Koerner of paper previously indexed from issue of Jan. 1931.

REINFORCEMENT. The Rational Reinforcement of Concrete, F. Dumas. *Engineering*, vol. 131, no. 3402, Mar. 27, 1931, pp. 409–410, 8 figs. Study of distribution and arrangement of steel in secondary reinforcement necessitated by shearing forces; author advocates policy of following with steel as closely as practicable tension lines of principal stress; by proceeding on these lines he has found it possible to reduce very materially quantity of steel which has hitherto been considered necessary in previous official plans for bowstring girders. Previously indexed from Annales des Ponts et Chaussées, Sept.-Oct. 1930.

CONSTRUCTION INDUSTRY

ACCIDENT PREVENTION. Accident Prevention in Construction, C. Robertson. *Contract Rec.*, vol. 45, no. 13, Apr. 1, 1931, pp. 393–394. Progress of safety movement in Ontario and program of Construction Safety Association; accident analysis.

CONVICT LABOR. Convict Labor Competition, G. B. Walbridge. *Constructor*, vol. 13, no. 3, Mar. 1931, pp. 36–38 and 43, 2 figs. Contractors advance plan for elimination of convict labor competition with free labor; manufacturers gain law; situation in Virginia; emergency employment.

PUBLIC UTILITIES. Construction by the Public Utilities, O. R. McGuire. *Constructor*, vol. 13, no. 3, Mar. 1931, pp. 30–31 and 56. Member of Virginia Bar argues that practice of public utility companies of handling their own construction operations, through day labor or subsidiary construction organizations, is inimical to public interest. Instances of public loss resulting from abandonment of competitive contract method are cited.

DAMS

CONCRETE GRAVITY, CANAL ZONE. Madden Dam, Power Plant, and Appurtenant Works on Chagres River, Canal Zone, to Cost $12,000,000. *West Construction News*, vol. 6, no. 6, Mar. 25, 1931, pp. 146–149, 4 figs. Description of proposed straight concrete gravity dam, 220 ft. high, 1,200 ft. long, also of several earth, gravel, and rock-fill saddle dams.

CUT-OFF WALLS. Sloping Cut-off Wall is Economic Feature of Rolled Earth Dam. *Eng. News-Rec.*, vol. 106, no. 13, Mar. 26, 1931, p. 522, 2 figs. Description of earth dam on Stanford University campus, Palo Alto, Calif.; sloping concrete cut-off wall used to reduce cost of formwork which would have been required by vertical

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wall. Maximum height is about 70 ft. with slope of 1¾ to 1 selected for cut-off.

DESIGN. Some New Ideas on Dams, E. Godfrey. *Civil Eng. (Lond.)*, vol. 25, no. 10, Mar. 1931, p. 529. Previously indexed from *Structural Engr.*, Jan. 1931 and *Engineer*, Feb. 6, 1931.

WEIRS, DISCHARGE. The Effect of Surface Waves on the Discharge over Weir, A. H. Gibson. *Instn. Civil Engrs.—Selected Eng. Papers*, no. 99, 1930, 18 pp., 7 figs. Theoretical study of effect of waves of sinusoidal or trochoidal profile; report on experimental investigation, carried out in Engineering Department of University of Manchester, on weirs of four different types. Wave-disturbance increases discharge over weir; with trochoidal waves it depends upon wave-length and periodicity; with waves whose height does not exceed mean head on weir-crest, correction may be applied which will enable effect on discharge to be computed within 1 per cent.

FLOOD CONTROL

CONNECTICUT. Building a New Dike with a Sheet Pile Cut-Off, W. S. Brewer. *Contractors and Engrs. Monthly*, vol. 22, no. 4, Apr. 1931, pp. 59–62, 5 figs. Report on construction of South Meadows dike, at Hartford, Conn.; total length 3 mi., 50 ft. wide on top; sheet pile cut-off, consisting of steel piling, ⅜ in. thick, Bethlehem section AP-16, was driven by two hammers working in fixed leads on traveler running on rails at one side of line of sheeting.

EMBANKMENTS. Calculating Floodflow over an Embankment, A. S. Fry and G. H. Hickox. *Eng. News-Rec.*, vol. 106, no. 14, Apr. 2, 1931, pp. 557–558, 3 figs. Calculation of flow of floodwater over embankment of Missouri Pacific Railroad at Newport, Ark., on basis of experiments by D. L. Yarnell and F. A. Nagler, at University of Iowa; experiments confirm use of broadcrested weir formula.

LEVEES. An Analysis of Equipment Used on Levee Construction Along the Mississippi. *Pub. Works*, vol. 62, no. 4, Apr. 1931, pp. 24–25 and 63–64, 12 figs. Review of recent tendencies in selection and method of operation of equipment.

MISSISSIPPI RIVER. Constructing the 35-Mile New Madrid Floodway Levee, T. T. Knappen. *Eng. News-Rec.*, vol. 106, no. 16, Apr. 16, 1931, pp. 636–641, 7 figs. Graphs of five equipment processes in placing 11,000,000 yd. of earth in levee embankment ranging from 8 to 22 ft. in height; data on construction with draglines in series; construction with tower excavator; construction by tractors and wagons; drag line and railway haulage; hydraulic dredge construction; engineering direction.

The Project for the Control of Floods in the Mississippi Valley, W. T. Hannum. *Baltimore Engr.—Anniversary No. and Year Book*, vol. 5, no. 11, Feb. 1931, pp. 14–18. Brief history of work since establishment of Mississippi River Commission in 1879; provisions of project recommended by Chief of Engineers to Board of Engineers for Rivers and Harbors.

FLOW OF FLUIDS

WATER. Method of Calculating Flow of Water in Pipes and Intakes, R. W. Angus. *Contract Rec.*, vol. 45, no. 11, Mar. 18, 1931, pp. 337–340, 4 figs. Elementary discussion of typical water supply problems; friction loss in pipes and fire hose; effect of end connections; short pipes; long pipes; water meters; intake pipe; and curves showing relations between flow and friction loss.

FOUNDATIONS

EARTH PRESSURE. A Generalized Mathematical Determination of Earth Pressure from the Wedge Theory, M. K. Rice-Oxley. *Instn. Civil Engrs.—Selected Eng. Papers*, no. 90, 1930, 8 pp., 2 figs. Derivation of equations, which enable earth pressure to be determined mathematically from wedge theory for any given case without restrictions as to slope of back, angles of repose, surcharge, and friction on back, and can be applied to wall of any given height, and earth of any given weight per unit volume.

HIGH BUILDINGS. Skyscraper Foundations in Quicksand Area Built Within Open Cofferdam, G. W. Glick. *Eng. News-Rec.*, vol. 106, no. 13, Mar. 26, 1931, pp. 515–519, 7 figs. Usual pneumatic caissons replaced by full-lot cofferdam for 60-story City Bank Farmers Trust Building in lower Manhattan; lower Manhattan foundation history; cofferdam design; cross-lot bracing; cross section of cofferdam wall; drainage system; transit-mixed concrete used; and condition of old caissons.

OFFICE BUILDINGS. New York Newspaper Building New Home, R. G. Skerrett. *Compressed Air Mag.*, vol. 36, no. 4, Apr. 1931, pp. 3440–3445, 16 figs. Construction of foundation for 10-story building of New York Telegram on West St., where Hudson River once flowed.

TESTING. Penetration Tests Give Bearing Power to Deep Subsurface Soils, G. Paaswell. *Eng. News-Rec.*, vol. 106, no. 14, Apr. 2, 1931, pp. 570–572, 6 figs., see editorial comment on pp. 547–548. Report on determination of bearing power of subway section sight on Houston and Essex streets in New York City; steel points pushed down from surface predetermine load capacity and probable settlement of soil under section of New York subway having building load surcharge; sand action under concentrated load. Before Am. Soc. Civil Engrs.

HYDRAULIC ENGINEERING

RESEARCH. Application of Hydraulic Laboratory Researches, I. A. Winter. *Am. Soc. Mech. Engrs.—Advance Paper*, for mtg. Apr. 20–23, 1931, 9 pp., 16 figs. Results of laboratory investigations made in connection with hydro-electric power-plant designs; establishing policy of conducting research, method of testing, and comparisons of laboratory and field results; advantages of model investigations; deficiency of scientific knowledge incidental to power-plant design; complex flows created by manufactured structures, such as spillways, canals, penstocks, and hydraulic machines; slight changes in shapes raise or lower efficiency of hydraulic machinery as much as 1 per cent.

STRUCTURES, TRANSITIONS. The Design and Construction of Complicated Hydraulic Structures, C. P. Dunn and I. E. Burks. *Engineering*, vol. 131, no. 3401, Mar. 20, 1931, pp. 390–391. Before Eng. Inst. Canada, previously indexed from Eng. Jl., Jan. 1931.

HYDRO-ELECTRIC POWER PLANTS

MISSOURI. Construction Features of Osage Hydro-Electric Development, A. W. Clark. *Eng. News-Rec.*, vol. 106, no. 13, Mar. 26, 1931, pp. 523–528, 8 figs. Report on construction of 129,000-kw. project near Bagnell, Mo.; power station is integral with masonry dam, having length of 2,543 ft. and maximum height above bedrock of 148 ft.; cofferdam and river diversion; concrete plant was equipped with four mixers of capacity of 60 cu. ft.; reservoir has flooded area of 61,000 acres and shore line of over 1,300 mi.; power line construction.

INLAND WATERWAYS

CANALS. New Welland Ship Canal Greatly Facilitates Traffic, F. R. Stewart. *Commerce Reports*, no. 12, Mar. 23, 1931, p. 773. Cargo traffic increased; permissible draft extended to 18 ft.; large cargoes held in winter storage at Port Colborne.

Gate Lifter for Welland Ship Canal. *Can. Ry. and Mar. World*, no. 397, Mar. 1931, pp. 178–179, 1 fig. Floating crane capable of lifting largest gate leaf used in Welland Ship Canal; weight 500 tons; steel pontoon 90 ft. long, 66 ft. wide, and 26 ft. deep; electric hoisting and control mechanism; power plant consists of oil-burning Scotch marine boiler 10 ft. diam. by 11½ ft. long, 160 lb. per sq. in. working pressure; 300-hp. engine direct connected to 200-kw.; 230-d.c. generator turning at 400 r.p.m.

The Welland Ship Canal—XVIII. *Engineering*, vol. 131, no. 3403, Apr. 3, 1931, pp. 440–443, 30 figs. Pontoon gate lifter is 90 ft. long by 66-ft. beam, and of molded depth of 26 ft. and loaded draft of 20 ft.; it is specially shaped to be maneuvered in confined spaces, such as lock chambers; pontoon is designed on requirements of gate-lifting gear; typical conditions under which gate-lifter will have to work are indicated.

The Welland Ship Canal—XVIII. *Engineering*, vol. 131, no. 3401, Mar. 20, 1931, pp. 380–381, 10 figs., some on p. 394. Provisions made for maintaining gates in good condition.

OPERATION. Waterway Transportation from the Viewpoint of Operation, T. Q. Ashburn. *Am. Soc. Civil Engrs.—Proc.*, vol. 57, no. 4, Apr. 1931, pp. 629–634, 1 fig. Authors closure of discussion of paper indexed in Engineering Index 1930, p. 944, from issue of Mar. 1930.

RIVERS, IMPROVEMENT, CHINA. Conservancy Works on the Liao River, North China, P. N. Fawcett. *Instn. Civil Engrs.—Selected Eng. Papers*, no. 100, 1930, 17 pp., 10 figs. partly on supp. plate. Tidal and other hydrological data and description of weirs and locks.

UNITED STATES. Silk Shipments by Canal Gain, Due to High Rail Rate, J. Black. *Textile World*, vol. 79, no. 15, Apr. 11, 1931, pp. 59 and 107, 2 figs. Question of rail versus waterway shipment of raw silk from Pacific Coast to New York has again assumed paramount importance, due to failure of eastern trunk lines to concur with transcontinental railroads in reducing rate from $9 to $6 per 100 lb. of raw silk; table showing coast-to-coast raw silk shipments by rail and water in bales.

IRRIGATION

CHINA. Getting Yellow River Water on the Saratsi Plain, O. J. Todd. *Far East. Rev.*, vol. 26, no. 2, Feb. 1931, pp. 80–83, 9 figs. Description of gravity irrigation project which is to give partial relief to area of nearly 2,000,000 mi. of flat farm land, lying south of Peiping-Suiyan Railway and north of Yellow River immediately east of Tenkow station; construction of main canal over 40 mi. long, 45 to 60 ft. wide on bottom.

MATERIALS TESTING

WIRE ROPE. The Preparation of Pieces of Wire Rope for Test, A. Dickson. *S. African Instn. Engrs.—Jl.*, vol. 29, no. 7, Feb. 1931, pp. 146–150, 2 figs. Methods of preparing test pieces in such a way as to insure equal distribution of load over wire strands; sketches illustrate details of test clamps.

MUNICIPAL ENGINEERING

MEASUREMENTS. Measurement and Control of Municipal Sanitation. *Mun. Sanitation*, vol. 2, no. 4, Apr. 1931, p. 192. Indexed in *Engineering Index* 1930, p. 192, from Int. Assn. Street Sanitation Officials Report, Sept. 1930.

SOUTH AFRICA. Municipal Works Projected for 1931. *S. African Eng.*, vol. 42, nos. 1 and 2, Jan. 1931, pp. 3–6 and Feb., pp. 29–30, 8 figs. Listing of important undertakings of electricity, water supply, road works, and sewerage in South Africa; costs.

PORTS AND MARITIME STRUCTURES

BREAKWATERS, SOUTH AFRICA. Damage to and Repair of the Breakwater, Table Bay Harbour, 1928, L. H. A. Shadwell. *Instn. Civil Engrs.—Selected Eng. Papers*, no. 102, 1930, 10 pp., 3 figs. Report on damage and method of repairing breakwater extension, some 700 ft. long, consisting of four separate walls of sluice-work built at angle of 78 deg., founded in sandy bottom which is practically level.

HARBOR IMPROVEMENTS, CHINA. The Training Wall Across the Liao Bar in Manchuria, P. N. Fawcett. *Am. Soc. Civil Engrs.—Proc.*, vol. 57, no. 4, Apr. 1931, p. 649, 1 fig. Author's closure of discussion of paper indexed in *Engineering Index* 1930, from issue of Oct. 1930.

PIERS, CONSTRUCTION. Construction of Screw-Pile Jetty at Bhavnagar, D. Kennedy. *Instn. Civil Engrs.—Selected Eng. Papers*, no. 95, 1930, 13 pp., 4 figs. Report on construction of main jetty, 228 ft. long by 42 ft. wide on four rows of piles of solid steel, 6 in. in diam.; method of screwing; testing of piles; design of screw; withdrawing damaged piles; tests in England; provision of new screws; use of water-jet; test of new screws; slipping of screws; final test.

SURVEYING. Bombay Harbor Survey and Tidal Model, J. McClure. *Engineering*, vol. 131, no. 3398, Feb. 27, 1931, p. 296. Paper before Instn. Civil Engrs. previously indexed from Excerpt Min. of Proc., 1931.

PUBLIC WORKS ENGINEERING

NIGERIA. Public Works in Nigeria, C. L. Cox. *Instn. Civil Engrs.—Selected Engineering Papers*, no. 93, 1930, 14 pp. Progress made in roads and bridges, water works, electricity and power, railways, harbor works.

RAILROADS, STATIONS, AND TERMINALS

FREIGHT. Freight Terminal Built to Meet Needs of the Future. *Elec. Traction*, vol. 27, no. 3, Mar. 1931, pp. 145–146, 4 figs. Chicago, South Shore, and South Bend Railroad completes new South Bend terminal facilities to speed up freight deliveries.

ROADS AND STREETS

ASPHALTIC CONCRETE CONSTRUCTION. Malaga-Fowler Section of Golden State Highway, California, R. W. Edwards and N. L. James. *West Construction News*, vol. 6, no. 6, Mar. 25, 1931, pp. 142–146, 7 figs. Peninsula Paving Company sets nation-wide production record on 7.5-mi. state highway contract south of Fresno by placing 43,560 tons of asphaltic concrete pavement in 42 working days; average vialog reading 7.4; handling and stockpiling materials; construction plant; production and cost of delays.

ASPHALT, WEST VIRGINIA. Construction in West Virginia, H. J. Spelman. *Roads and Streets*, vol. 71, no. 3, Mar. 1931, pp. 103–106, 13 figs. Author's experience in West Virginia in construction of 164 mi. of mixed-in-place top course, ranging from thin resurfacings to smooth-up rough macadam to 2-in. top courses on knapped or crushed stone bases; use in widening old roads and in smoothing up old bituminous macadam; costs. Before Asphalt Paving Conference.

BITUMINOUS, UNITED STATES. Low-Cost Bituminous Treatment on Roads in the Western States—I. J. T. Pauls. *Am. City*, vol. 44, no. 4, Apr. 1931, pp. 128–131, 5 figs. Leading types of treatments; mixed-in-place treatment of crushed gravel and stone roads; methods are adaptable to local traffic conditions; characteristics of binder and aggregate; tests to determine suitability of aggregate; variety of light-oil products used; specifications agreed upon by Western state officials; use of heavier oils desirable in mixed-in-place construction.

CONCRETE, CONSTRUCTION. Concrete Road Construction. *Quarry and Roadmaking*, vol. 36, no. 400, Mar. 1931, pp. 120–126, 3 figs. Extracts from report on construction of concrete roads issued by British Portland Cement Assn., relating to findings of Sixth International Road Congress at Washington; typical cross sections and details of formwork; roads of mass or reinforced concrete; road surfacing with concrete "sandwich" system; cement-grouted macadam; haunches and abutments.

CONSTRUCTION. Tandem Paving Job Shows Increased Production. *Roads and Streets*, vol.

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71, no. 3, Mar. 1931, pp. 87–89, 10 figs. Comparative field study of advantages of tandem plan of operating two pavers in constructing 12 mi. of Missouri project 307-A, in Dallas County.

GRAVEL, CONSTRUCTION. Asphaltic Surfacing of Gravel Roads, C. R. Stokes. *Can. Engr.*, vol. 60, no. 12, Mar. 24, 1931, pp. 17–18 and 57. Description of two types of construction employed on experimental road in Florence County, Wisconsin; preparing subgrade; hot mix type construction; labor; quantity of materials used; improvements and details. Before Ninth Asphalt Paving Conference.

MACADAM. Pre-mixed Tar Macadam, G. E. Martin. *Eng. News-Rec.*, vol. 106, no. 14, Apr. 2, 1931, pp. 568–569, 3 figs. Study of technology of its manufacture, handling and placing properties, and place among oil-mixed surfacing materials for roads; British practice remodeled; experiments; weight of finished pavement per sq. yd. for various thicknesses, essentials of good mixtures; shipping and handling possibilities.

SUBGRADE TREATMENT. Applicability of Sand and Gravel in the Correction of Sub-Grade Soils, F. V. Reagel. *Nat. Sand and Gravel Bul.*, vol. 12, no. 2, Feb. 1931, pp. 56–59. Application of soil studies to highway work; classification of soils; correcting defects of various classes as they are met with under field conditions in highway work; oiling of certain types of soils prior to placement of finer granular material and preliminary application of fine material to all clay and silt subgrades for greater soil stability.

SEWERAGE AND SEWAGE DISPOSAL

CHLORINATION. Ammonia-Chlorine Reactions and Lime-Chlorine Process, L. H. Enslow. *Water Works and Sewerage*, vol. 78, no. 3, Mar. 1931, pp. 55–59, 3 figs. Discussion of more important and established ammonia–chlorine reactions and chloramine production in water and sewage treatment, also of lime-chlorine process in sewage treatment; rôle of pH in controlling chloramine production in sewage and water; efficacy of chloramines versus chlorine; production of prepared chloramine; use of lime or chlorinated lime in sewage chlorination. Bibliography.

DISPOSAL PLANTS. Operation and Control of Sewage Treatment Plants. *Mun. Sanitation*, vol. 2, no. 4, Apr. 1931, p. 191, 2 figs. Purpose of sedimentation tanks and septic tanks; mechanically cleaned and plain settling tanks with separate sludge digestion. (Continuation of serial.)

FILTRATION. Distributing Sewage on Coarse-Grained Filters, A. E. Kimberly. *Water Works and Sewerage*, vol. 78, no. 3, Mar. 1931, pp. 67–69. Historical aspects; distribution as related to efficiency; filter loadings; table of representative Ohio trickling filter plant data; advantages of sprinkling distributors.

RURAL. Septic Tank Sewage Disposal for the Outlying Institution, W. A. Hardenbergh. *Plumbers Trade Jl.*, vol. 90, no. 8, Apr. 15, 1931, pp. 12–13 and 37, 2 figs. Locations and connections for septic tanks and filters; siphons and other auxiliary equipment pertaining to latest methods of waste elimination beyond sewer lines.

SLUDGE DIGESTION. Laboratory Studies of Sludge Digestion, A. M. Buswell and S. L. Neave. *State Water Survey, State of Ill.—Bul.*, no. 30, 1930, 84 pp., 4 figs. Theoretical and laboratory studies of chemical changes occurring during sewage-sludge digestion; bio-chemical changes in nitrogenous and carbonaceous matter; fats and soaps of sewage sludge; mechanism of anaerobic oxidations; Bach and Sierp's results on gas production; Duclaux distillation constants.

STREET CLEANING AND REFUSE DISPOSAL

SEATTLE. Street Cleaning in Seattle, D. A. Boyle. *Am. City*, vol. 44, no. 4, Apr. 1931, pp. 83–85, 2 figs. Flushing and pick-up sweeping; cooperation of public in sweeping sidewalk and using litter boxes; streets cleaned by districts; emergency services of flushers; costs.

SNOW REMOVAL. Modernized Snow Fighting Methods Effective in Chicago. *Elec. Ry Jl.*, vol. 75, no. 4, Apr. 1931, pp. 193–196, 7 figs. Surface lines have spent approximately $100,000 for improvements and additions to snow equipment during past year; operations completely revised and thoroughly coordinated; efficiency proved during recent storm.

STRUCTURAL ENGINEERING

ARCHES, SKEW, DESIGN. An Analysis of Multiple-Skew Arches on Elastic Piers, J. C. Rathbun. *Am. Soc. Civil Engrs.—Proc.*, vol. 57, no. 4, Apr. 1931, pp. 513–559, 15 figs. Analysis of ring of skew arch, including skew arches of more than one span; by placing skew equal to zero, method may be applied to multiple right arch on elastic piers; effect of accentric loads; experimental verification of theory by celluloid model; equations for skew arch, when abutments are free to rotate.

COLUMNS, FORMULAS. The Strength of Compression Members, E. S. Andrews. *Surveyor*, vol. 79, no. 2043, Mar. 20, 1931, pp. 357–359, 1 fig. Previously indexed from *Structural Engr.*, Mar. 1931.

CULVERTS, DESIGN. Circular Culverts, W. S. Gray. *Concrete and Constr. Eng.*, vol. 26, no. 3, Mar. 1931, pp. 214–218, 7 figs. Theoretical mathematical analysis of stresses due to various modes of loading on empty culvert or subway.

MODELS. Mechanical Solution of Indeterminate Structures, J. B. B. Owen. *Instn. Mun. and County Engrs.—Jl.*, vol. 57, no. 18, Mar. 3, 1931, pp. 933–937, 2 figs. Mathematical discussion of theory underlying solution of indeterminate structures by means of models.

TRAFFIC CONTROL

ACCIDENTS, PREVENTION. Street Accidents in Berlin. *Elec. Ry. Bus and Tram. Jl.*, vol. 64, no. 1596, Mar. 13, 1931, pp. 135–138. Interpretation of statistical data regarding distribution and causes of accidents, involving street railroads, motor buses, trucks, automobiles, bicycles, horse cars; classification of accidents according to localities and relation of car miles to number of accidents.

TUNNELS

CONSTRUCTION EQUIPMENT. Equipment's Place in Tunneling Progress, J. S. MacDonald. *Eng. News-Rec.*, vol. 106, no. 15, Apr. 19, 1931, pp. 601. General review of modern methods and recent progress, introducing series of six articles indexed separately.

RAILROAD, CONSTRUCTION. One-Mile Railway Tunnel Under City of Quebec. *Contract Rec.*, vol. 45, no. 12, Mar. 25, 1931, pp. 351–355, 5 figs. Design and construction of concrete-lined tunnel, 1 mi., 70 ft. long, with clear width inside of 16 ft. and clear height of 22 ft. 6 in.; side walls are vertical and top is semi-circular arch with radius of 8 ft.; construction equipment; in excavating tunnel bottom heading method was used; placing concrete lining.

VENTILATION. Tunnel Construction—III, Ventilation During Construction, R. H. Rogers. *Eng. News-Rec.*, vol. 106, no. 15, Apr. 9, 1931, pp. 608–610, 7 figs. Selection of equipment for supplying fresh air; efficiency of various types of ventilating equipment power units; operating costs for three types of motors operating at reduced speeds.

WATER SUPPLY, BOSTON. Construction of the Wachusett-Coldbrook Tunnels, D. C. Corner. *U.S. Bur. Mines—Information Cir.*, no. 6399, Feb. 1931, 6 pp., 5 figs. Modern tunnel-driving methods as exemplified in construction of 14-mi. Wachusett-Coldbrook Tunnel, for diverting additional water into Wachusett Reservoir, from which Metropolitan District of Boston receives its water supply; tunnel section shape and size required removal of 6.79 cu. yd. per linear foot; average cost per linear foot of tunnel excavation.

WATER SUPPLY TUNNELS, NEW YORK. City Tunnel No. 2—A Deep Pressure Tunnel for the Delivery of Water in New York City—Description and Construction Methods, H. R. Bouton. *Mun. Engrs.—Jl.*, vol. 16, *Fourth Quarterly Issue*, 1930, pp. 164–235 and (discussion) 236–239, 23 figs. Design and construction of longest continuous tunnel in world, extending about 20 mi. from Hill View Reservoir, in Yonkers, to terminal shaft at Hamilton Avenue and Hicks Street, in Brooklyn; tunnel will be 17 ft. in diam.; estimated quantities and prices bid; construction plant; excavation; caisson construction; shaft excavation in rock; tunnel excavation; inflows of water in shafts and tunnel; handling of explosives.

WATER SUPPLY TUNNELS, WASHINGTON. The Yakima River Pressure Tunnel. *Constructor*, vol. 13, no. 4, Apr. 1931, pp. 31–33, 4 figs. Construction of recently completed concrete-lined irrigation tunnel, 3,215 ft. long, with maximum carrying capacity of 925 sec-ft.; tunnel intake is circular in cross section with inside diam. of 111 in.

WATER PIPE LINES

SERVICE CHARACTERISTICS. Hydraulic Service Characteristics of Small Metallic Pipes, G. M. Fair, M. C. Whipple, and C. Y. Hsiao. *Harvard Eng. School—Pub.*, no. 58, 1930–31, pp. 499–532, 11 figs. Indexed in *Engineering Index* 1930, from New England Water Works Assn.—Jl., Dec. 1930.

WATER PUMPING PLANTS

DIESEL. Diesel Engines as Applied to Water Works Service, R. D. Hall. *Water Works and Sewerage*, vol. 78, no. 3, Mar. 1931, pp. 70–73, 4 figs. Paper before Am. Water Works Assn., indexed in Engineering Index 1930, p. 1399, from Can. Engr., July 15, 1930.

WATER RESOURCES

RAIN AND RAINFALL, DROUGHT. Drought and Its Remedy, J. P. Wells. *Water Works Eng.*, vol. 84, no. 7, Apr. 8, 1931, pp. 429–430 and 466, 2 figs. Problems of cities and towns in hilly or mountainous country; suggestions as to preparation for emergency caused by drought; problems of supplies from small fluctuating streams; determining run-off in low year; record of flow of Croton River used to estimate that of smaller stream.

SUPPLY, UNDERGROUND, CANADA. Regina's Underground Water Supplies, R. O. Wynne-Roberts. *Contract Rec.*, vol. 45, no. 13, Apr. 1, 1931, pp. 382–385, 1 fig. Before Am. Water Works Assn., previously indexed from Can. Engr., Convention number, Mar. 17, 1931.

SUPPLY, UNDERGROUND, NEW JERSEY. Ground Water Supplies in the Vicinity of Asbury Park, D. G. Thompson. *Dept. Conservation and Development State N.J.—Bul.*, no. 35, 1930, 50 pp., 4 figs. Report on observations made by writer since Sept. 1924, of water supplies of region; water horizons; consumption; quality of water; water-bearing capacity of formations; possibility of contamination of wells by salt water; recommendations for future work.

WATER TREATMENT

PLANTS. Settling Basins for Coagulated Water, J. R. Baylis. *Water Works and Sewerage* vol. 78, no. 3, Mar. 1931, pp. 61–65, 1 fig. Historical review; settling basin for larger filtration plants; settling basins where water is not subsequently filtered; settling basins for slow sand-filtration plants where water is coagulated at least part of time; settling basins with underdrains; tabulated data on settling basins for rapid sand filtration plants in United States. (To be concluded.)

PRE-AMMONIATION. Experiments in Chloramine Treatment for a Highly Turbid Water Supply, C. L. Ehrhart. *Water Works Eng.*, vol. 84, no. 6, Mar. 25, 1931, pp. 359–360 and 394. Experiments in use of ammonia and chlorine process upon extremely turbid waters of Mississippi River at St. Cloud, Minn.; weekly averages of conditions and treatments with use of chlorine alone and with chloramine process; results of change to chlorine-ammonia system; chloramine residuals at various taps; chloramines do not require more time for sterilization. Before Minn. Water Works Conference.

TASTE AND ODOR REMOVAL. Removing Tastes from a Badly Polluted Supply, M. M. Gibbons. *Water Works Eng.*, vol. 84, no. 6, Mar. 25, 1931, pp. 389–390 and 393, 1 fig. Difficulties in this respect and methods for overcoming them at Rahway, N.J.; character of river water; medicinal taste in city supply; taste removal in rapid sand filters; super-chlorination treatment; ammonia and chlorine treatment; potassium permanganate treatment; activated carbon treatment; taste trouble from molasses wastes and fermenting wastes; prevention of industrial wastes pollution. Before New Eng. Water Works Assn.

WATER ANALYSIS. Interpretation of Water Analyses, N. J. Howard. *Contract Rec.*, vol. 45, no. 11, Mar. 18, 1931, pp. 334–336. Relationship of analytical figures to water treatment; color and turbidity; taste and odor; hydrogen ion concentration; ammonia content; oxygen consumed and dissolved; chlorides, nitrates, and nitrites; gases in water; hardness in water; microscopic life.

Water Analysis and Water Purification, N. J. Howard. *Can. Engr.*, Convention number, Mar. 17, 1931, pp. 94–95. Paper dealing with subjects in simple language; free and albuminoid ammonia; microscopical and bacteriological examination of water. Before Am. Water Works Assn.

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ALGAE CONTROL. Vegetable Growths in Water Supplies, A. E. Berry. *Can. Engr.*, Convention No., Mar. 17, 1931, pp. 101–103. Classification of growths in water; nomenclature of plankton growths; where plankton is found; factors which influence growth effects of vegetable growths; color in water; effect of plankton upon filtration; plankton control measures; control of iron bacteria; odor nuisances from algae; toxic effects from algae decomposition.

AQUEDUCTS, COLORADO RIVER. The Colorado River Aqueduct for the Los Angeles Metropolitan Water District, W. A. Scott. *Am. City*, vol. 44, no. 4, Apr. 1931, pp. 86–88, 1 fig. General non-technical description of project, estimated to cost about $200,000,000; formation of water district; sources of local water supply; surveys for Colorado River aqueduct; Parker Route recommended by engineering board of review; features of Parker Route; terminal storage; removal of silt from water; appropriation of water.

ATTICA, N.Y. Creating a 600,000,000-Gallon Reservoir with a $30,000 Dam, J. P. Wells. *Water Works Eng.*, vol. 84, no. 6, Mar. 25, 1931, pp. 355–356, 2 figs. Description of water supply improvements of Attica, N.Y.; construction of earthen dam with concrete corewall 35 ft. in height and approximately 400 ft. long; standpipe at 100-ft. elevation is used for wash water for filters and for fire protection; unit prices for which dam was built.

OPERATION. Successful Water Works Operation, R. H. Corey. *Can. Engr.*, vol. 60, no. 14 Apr. 7, 1931, pp. 23–25 and 60. Indexed in *Engineering Index* 1930, p. 1888, from *Water Works and Sewerage*, Sept. 1930.